Medical Lib.

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PROCEEDINGS

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Section of Anæsthetics.

President—Dr. Z. MENNELL.

A Question on the Teaching of Ether Anæsthesia: With a Report of Four Deaths under Ether.

PRESIDENT'S ADDRESS.

By Z. MENNELL, M.B.

AFTER a few introductory remarks, the President said: I thought I could interest you most and promote discussion by asking you a simple question, and showing you two pathological specimens, which I know will appeal to you as practical teachers.

The question is this: What depth in a straight ether anæsthesia in an ordinary abdominal or tonsil case is it advisable to teach students to attain?

I am not concerned with the method of induction or the question of chloroform or mixtures, but only with unadulterated ether anæsthesia obtained by the open or closed methods, and always assuming a perfectly clear air-way.

I suppose we shall all agree that it is necessary to dilate the pupil, but are we justified in teaching that a widely dilated inactive pupil, with very shallow respiration, is safe? In fact, do we consider it advisable to teach the "deepest possible": and that no harm will arise as long as ether alone is used, and as long as the air-way is clear? This anæsthesia is commonly used in the modern tonsil operation, and I therefore include it in the question. If it is not expedient to teach the practice of this type of anæsthesia, what is the depth to which you are prepared to go?

A common method is to employ a semi-closed induction: this is followed by blowing oxygen continuously through ether—is this continuous use of oxygen justifiable in order to obtain the desired result?

What do you teach is the cause of the apnœa which occurs quite suddenly in the earlier stages of a dilated pupil—it alarms students and often the surgeon. Are we to regard this as safe? I will put forward my own views tentatively. This apnœa occurs at the moment when the adductors of the vocal cords are suddenly relaxed after they have been in a position of adduction due to the earlier paralysis of the abductors. This naturally gives a very free air-way and consequently over-ventilation. To those of you who have not examined the vocal cords under a really deep ether anæsthesia I would suggest that it is a most instructive experience. Personally, I believe that complete relaxation of the abdominal muscles cannot be obtained until these adductors have been paralysed. There is another point I want considered in dealing with this form of anæsthesia. I have heard of a good many, and personally have seen a few, instances of late convulsive movements, a jactitation in no way to

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be confused with the early "ether tremor," which is really a clonus. It is first manifested by a twitching of the muscles at the corners of the mouth or other facial muscles, and gradually spreads to the rest of the musculature; in one instance it was so marked that there was difficulty in closing the abdomen, the convulsive movements being in this case very severe. This condition is without question dangerous and must be due to a direct toxæmia or anoxæmia of the vital centres. It is, I think, the greatest argument against deep ether anæsthesia.

There is also the question of over-stimulation for long periods and consequent ensuing fatigue, as evidenced by falling blood-pressure. This really produces the condition which we know as shock, and to this I will refer again when I show the specimens.

Now, considering all these points, are we, as teachers, justified in teaching that very deep ether is as safe as is often claimed?

I feel there is a tendency in favour of returning to the general use of chloroform as a routine anæsthetic. It has been said that the only difference between fatalities under chloroform and those under ether was that the former occurred on the table and the latter subsequently. This is not true, and for two reasons:—(1) Ether is not the only anæsthetic which causes post-operative deaths. (2) Deaths from ether sometimes occur on the table though not with the same dramatic suddenness.

I have here the notes of four such cases, and I know of more. There is no question of the use of chloroform in any of the four.

Three of these presented the same symptoms. I will not trouble you with details. One was a kidney case and two were cases for enucleation of tonsils—one adult and two children.

The patients were all given ether and were all kept under ether by means of oxygen blown through a large Junker bottle. In each case the anæsthesia was deep. Two of the patients received the anæsthetic at the hands of an expert anæsthetist, and in one case it was administered by a good, but less experienced man.

The point I wish to emphasize is that pathologically they all presented the same condition.

On the screen you will see a section of kidney showing profound dilatation of all the minute vessels. You will see the capillaries full of red cells, and this virtually means death due to bleeding into the tissues.

This corresponds to the condition we call shock. It also corresponds to the condition which was shown by Dr. Dale to occur when histamine is injected into animals. Why does this occur? It is difficult to understand how ether can produce it merely by over-stimulation. The ether had been tested; there was no question of impurity. Is it possible that over-oxidation due to an unnaturally clear air-way, and excessive use of oxygen, oxidized the histadine which is normally present in the body and liberated histamine into the circulation? The similarity between the specimen shown and those produced by Dr. Dale experimentally is very striking. Professor Dudgeon, who prepared this specimen, has similar specimens from the other two cases.

Three such specimens obtained within a space of a few years indicate more than coincidence; this condition must be looked upon as a cause of death from ether. The only other explanation is that the excessive use of oxygen with a very free air-way is dangerous. I spoke of jactitation occurring in some cases, and this seems to me to be similar to the convulsive movements small animals present when put into a jar of oxygen. It is a noteworthy fact that when experimenting with oxygen various scientists are careful not to use a higher percentage than 20 per cent., though none of them as far as I know have given any reason.

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I will now demonstrate the second specimen which I am showing—death due to fat embolism or infarction: again, under pure ether. I have had the literature on this subject looked up; it is mostly in German, but I have been unable to trace a single death from this cause occurring under an anæsthetic.

The following is a brief outline of this case, which happened when I was teaching:—

A senior student gave a nitrous oxide ether sequence followed by open ether. I could not detect anything abnormal in any way, either in the induction or consequent anæsthesia, but the patient was not actually in my hands.

The patient was a man, aged 45, suffering from deformities due to infective polyarthritis of three years' duration, apparently quiescent, who had been bed-ridden for the three years. For this condition the operation was to be the first of a series to correct the deformities. The actual operation was lengthening the tendo Achillis followed by plaster. He was under the anæsthetic for half an hour. When the plaster had been applied, the anæsthetic was stopped and he was left in the theatre for it to set. The next case was anæsthetized under my supervision, and I took this second patient into the theatre. I noticed nothing wrong with the first patient, and it was certainly not until ten minutes after the anæsthetic had been stopped that I noticed he was pale. I went over to him and found the respiration very shallow, pulse weak and irregular. The pupil was small with a brisk corneal reflex, and the man was swallowing. I thought he was about to vomit. The surgeon asked me if anything was wrong, and I was so sure of the vomiting that I said "No." However, that man died and in a manner I have not seen before under an anæsthetic.

I could not explain it in any way, but I have seen old people die in a similar manner after a prolonged illness. I could not say whether it was due to heart failure or to cessation of respiration; he was almost conscious, and there was no doubt that he died when turned over on to his back. There was a marked sudden change of colour to the death pallor, but no cyanosis.

The slides show enormous deposits of fat in the vessels, which indicates an aggregate of some pounds or pints of liquid fat in the circulation. Where all the fat came from I cannot imagine nor can I obtain any explanation. It is true, of course, that ether is a solvent of fat, but it is not conceivable that such a quantity could have been held in solution and then deposited as the ether was thrown off. Again the operation was upon a tendon in which there is but little fat—it is not as if a large amount of bone-marrow had been liberated into the circulation.

Cases of death from fat-embolism have been reported and they all occurred in bed-ridden patients; attempts have been made to produce death from fat-embolism in animals, but so far have failed.

I have had these two drawings made from the slides prepared by Professor Dudgeon showing the kidney and heart muscle; it was a great pity that a specimen of the blood was not kept.

The futility of the coroner's court in ascertaining the scientific cause of death in these cases is amply exemplified—the verdict was one of "death by misadventure under an anæsthetic which was the proper one to use and properly administered." It was only by the courtesy of the coroner and his pathologist that specimens of these cases have been obtained and examined properly.

In bringing forward these four cases of death under ether my object has been to determine, if possible, the general feeling of the Section about the question of the depth of anæsthesia which is justified. I believe that any trace of anæsthetic or disturbance of any sort would have killed the last patient; it is a curiosity and an inevitable risk; but the same cannot be said of the other three cases. The similarity in all three cases is unmistakable and in none of them can the surgical interference have accounted for so marked a degree of shock.

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In conclusion, before opening the discussion, I hope I have not been misunderstood. I have been provocative on purpose and I still adhere to the belief that ether is by far the safest anæsthetic we have, and that, given reasonable skill, anything which can be done with any other anæsthetic can be done as well and with greater safety with ether.

Ether anæsthesia is what we ought to teach as a routine—of that I am convinced, but I admit I have lost confidence as to the safety of deep ether for prolonged operations. What ought we to teach?

Discussion.—Professor L. S. DUDGEON referred to the similarity in the pathological findings in the three cases which Dr. Mennell described of death due to ether poisoning and death due to shock. He raised the question as to whether such cases, and those of pulmonary thrombosis, were of more common occurrence since modern methods of deep ether anæsthesia had been employed.

Dr. LLEWELYN POWELL said that what he taught and practised was that the lightest anæsthesia compatible with the requirements of the surgeon should be aimed at. He thought that if the patient's air-way were kept free there would be enough oxygen in the air to keep the blood oxygenated without resort to an oxygen cylinder. Dr. Mennell had said that ether could be used in competent hands for any case. He (Dr. Powell) had that very afternoon given an anæsthetic for diathermy in the mouth. He had not used ether, but had used chloroform.

Dr. BLOMFIELD said that he believed it possible, and the right practice, to meet the surgeon's requirements with a degree of narcosis less profound than that described by Dr. Mennell. He would like a pupil not dilated to its utmost. The sections made from the cases of ether fatality were most instructive, for although we knew, of course, that ether in excess could kill, the opinion generally held was that death came about through paralysis of the respiratory and vasomotor centres, and an appearance of the peripheral vessels such as that demonstrated would not have been anticipated.

Dr. C. F. HADFIELD expressed great interest in the description of late ether jactitation, as he had recently investigated quite a number of cases which had occurred at St. Bartholomew's Hospital. The last of these, which had ended fatally, was so marked that the particular batch of ether had fallen under suspicion and its use had been discontinued. The autopsy on this particular case, however, had shown that the patient's urinary system was in such a condition that the convulsions could hardly be ascribed to anything but uræmia. The makers of the ether had had the batch most carefully examined both in their own laboratories and by an independent firm of analysts. It had also been examined on behalf of the Anæsthetics Committee by Dr. King, chemist to the Medical Research Council. All three reports showed an ether of unusual purity. Dr. Hadfield had never himself met with the condition and had on inquiry found that several anæsthetists of greater experience than himself were equally ignorant of it though some others had seen occasional cases. Portions of the suspected batch had in the ordinary course been previously delivered to other hospitals but no ill effects were observed from its use at any except one—the Royal Northern Hospital—where several cases of jactitation had been reported, though none of them appeared to have been at all serious. He (the speaker) had himself used several bottles of this ether to his entire satisfaction. He found it difficult to believe that this late jactitation was a symptom of ether overdose—as Dr. Mennell suggested—for he thought he had himself overdosed patients with ether quite as much as anyone without meeting a case.

With regard to the size of the pupil under ether Dr. Hadfield said that he had come to the conclusion that the information it conveyed was of small importance. At the same level of anæsthesia he had frequently seen marked changes which were beyond his comprehension. He was bold enough to teach students that so long as colour, pulse and respiration were

entirely satisfactory, even widely dilated pupils could almost be neglected. With any weakening of the pulse or breathing, however, the large pupil was a danger sign.

Dr. Hadfield also drew attention to a class of case which he was inclined to ascribe to the pathological condition so well illustrated by Dr. Mennell's excellent slides. These were cases in which the surgeon removed the necessary portion of a malignant tongue and also dissected out the glands of the neck at the same sitting. In some four or five instances he (the speaker) had known the patients, who had left the theatre in apparently good condition, to collapse and die with dramatic suddenness a few hours later.

Mr. C. LANGTON HEWER said that he was interested in the President's remarks of ether spasm occurring during deep anæsthesia, as he had seen one case at the end of a two-and-a-half hours' anæsthesia with nitrous oxide-oxygen and ether, given by the endotracheal method. The spasm involved all the voluntary muscles of the body and lasted for a quarter of an hour. The temperature rose to over 106° F. (presumably owing to the muscular effort) but fell rapidly, and the patient made an uninterrupted recovery. It was a singular fact that a large number of similar cases had occurred in all parts of London during a few weeks, but apparently none either before or after. It was possible that the exceptionally hot weather during this period might have played its part in the causation of this alarming condition. He (Mr. Hewer) suggested that the most rational treatment for ether spasm was rapid "de-etherization" with a 90 per cent. oxygen, 10 per cent. carbon dioxide mixture.

Dr. H. P. CRAMPTON said he thought that the patient was never really safe till he was "down and out," but that this state must be brought about gradually. He considered the risk attending inspiratory spasm during light ether anæsthesia to be greater than that of gradual over-dosage. Once the patient was deeply anæsthetized it required a very small quantity of ether to maintain this level.

Dr. F. P. de CAUX said that the only cases in which he gave sufficient ether to dilate the patient's pupils to the maximum were upper abdominal cases. He vaporized his ether in these cases with gas and oxygen, the nitrous oxide being used to dilute the oxygen, and the vapour being given by the closed method. He considered that in skilled hands this was a perfectly safe thing to do, but it should be the last thing the student should be taught, as the breathing became so shallow at this depth that, unless a perfect air-way were maintained, trouble would be bound to follow.

Dr. MENNELL (President) (in reply) said the discussion had not quite elicited a reply to his question as to the depth of anæsthesia to be taught students. Personally, he brought deep ether to the point of relaxation of the vocal cords in abdominal work, and then very little was necessary to maintain complete relaxation. He no longer used continuous oxygen. Apnœa occurred sometimes when the cords relaxed. He had been unable to trace any record of a case of a death from fat-embolism under an anæsthetic.

Elting and Martin reported two deaths from this cause after fractures of the long bones, and mentioned others, post-operative and post-traumatic, in which movement had precipitated death. Fat was excreted through the kidney and was present in the urine. Three conditions were necessary: (1) Fat liberated from the fat cell. (2) Fat must be liquid and accessible to the circulation. (3) There must be some force to drive it into the blood-vessels.

In reply to Dr. Powell, he said that apnœa occurred without the use of oxygen. Deep ether was extensively in use in London, especially for tonsil work.

In answer to Dr. Hadfield, he said that the patients in all three deaths reported had a bright red colour when death occurred. Colour could not be taken by itself as an indication of the well-being of the patient, and this was explained by the peripheral dilatation of the capillaries. Jactitation had occurred under another make of ether than the one mentioned.

With regard to Dr. Crampton's remarks, he would say that it was very difficult to obtain deep ether anæsthesia after injection of morphia, as the respiration was depressed by that drug. Dr. Crampton's "down and out" corresponded to the relaxation of the cords.

With regard to the slide showing peripheral dilatation, were Members aware that Dr. Dale

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had pointed out that unanæsthetized cats could tolerate large doses of histamine, but when anæsthetized showed signs of shock from much smaller doses?

Histamine + ether = shock
Histamine + hæmorrhage = shock (out of all proportion to the hæmorrhage)
Histamine + N_2O = no shock

Maubner and Pick referred to "latent shock poisons," causing the same condition under anæsthetics. The oligæmia was caused by the passage of plasma out of the vessels and to retardation of the rate of flow of the blood; this was due to loss of tone of the vessels.

Clinical Section.

President—Sir HERBERT WATERHOUSE, F.R.C.S.

CASES.

Mediastinal Tumour with Chylothorax.

By B. T. PARSONS-SMITH, M.D.

F. G., AGED 65, male. Occupation: optician.

Patient was admitted to hospital complaining of an increasing degree of breathlessness on exertion during the past six months following an attack of quinsy, a sensation of fullness after meals and recently a tendency to swelling of the ankles. Previous health uniformly good.

Examination.—Moderately well nourished; of healthy appearance; slight cyanosis and obvious respiratory embarrassment; left pleural effusion with displacement of heart to right; no evidence of heart disease.

Electrocardiogram shows left ventricular preponderance, appearances otherwise normal: liver enlarged; spleen not felt; swollen gland in left axilla; slight œdema of ankles; urine, a trace of albumin. Wassermann reaction negative; blood-count normal. X-ray examination shows invasion of the posterior mediastinal space by somewhat ill-defined shadows of oval shape and moderate opacity (best observed after aspiration of the left pleural cavity with air replacement), also an opaque area (roughly the size of a small orange) towards the periphery of the right lung.

Analysis of fluid (removed by aspiration on four occasions during the past two months): Maize-coloured opaque fluid; no definite clot on standing; cells almost entirely mononuclear; a few red blood-discs present; no fat globules; fat content 2 per cent. (consistent with fluid being chylous in character).

Pseudo-Hermaphroditism.

By PHILIP TURNER, M.S.

V. S., ? SEX, aged 15 months.

History.—Lump in right groin, varying in size, up to that of pigeon's egg. Sometimes painful. Pain in lump and vomiting on day of admission. Lump had been "reduced."

Examination.—Movable lump in each groin, not emerging from internal abdominal ring. Both lumps firm, oval in shape, with long axis in line of inguinal canal, in which they appeared to move. Lumps about the size of hazel nuts.

Operation.—Lump in right groin explored. It lay in the inguinal canal, was covered in by a tunica, and had the external appearance of a *testicle*, with a vas, pampiniform plexus, and epididymis.

Hernial sac also present on right side. Through this a finger in the pelvis could feel no organ suggesting uterus, Fallopian tube or ovary. Hernial sac removed. External genitals those of perfect *female*.

Dr. F. PARKES WEBER contrasted this apparently extreme example of male pseudo-hermaphroditism with the cases of female pseudo-hermaphroditism (and those of merely female

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virilism) due to the endocrine action of adenomata of the suprarenal cortex. For the latter condition—or for excessive activity of the suprarenal cortex without any actual tumour-formation—Professor E. Mathias (Breslau) had lately introduced the term "Inter-renalism," because, as he insisted, the suprarenal cortex represented the "inter-renal body" of certain lower animals. In the present case the condition was such that the male pseudo-hermaphroditism gave the child the external appearance of a *quite normal* female; there was no appearance of any abnormal endocrine action at work.

Charcot's Arthropathy of Wrists.

By C. WORSTER-DROUGHT, M.D.

WILLIAM H., aged 48, painter, has complained of swelling and weakness of right wrist since 1918. The onset was gradual without pain. About a year later the left wrist became slightly affected and the metacarpo-phalangeal joints of left index and middle fingers began to enlarge.

Physical examination.—The right wrist is irregularly enlarged and much deformed. On the dorsum, towards the ulnar side there is a large swelling containing some fluid with bony thickening beneath. A similar, though smaller, swelling is situated on the radial side of the joint. The enlargement is neither painful nor tender. Flexion and lateral movement at the joint are moderate and extension very limited. Some wasting of interossei with pronounced extensor tendons.

The left wrist, somewhat swollen towards the ulnar side, is not tender and the movements are fairly good. The metacarpo-phalangeal joints of the left index and middle fingers are also swollen and enlarged. In the right axilla is a large glandular but movable mass, which is neither painful nor tender. Epitrochlear glands in each arm are also enlarged.

The pupils react to accommodation but not to light; the right pupil being larger than the left. Other cranial nerves are normal. Some tendo Achillis analgesia. Arm-jerks and ankle-jerks are normal; knee-jerks present; right brisker than left; no definite inco-ordination.

Blood: Wassermann positive. Cerebro-spinal fluid: 16 lymphocytes per c.mm., globulin increased; Wassermann positive. Colloidal gold reaction shows curve of luetic type.

Dr. F. PARKES WEBER drew an analogy between this case, which might be called one of "cervical tabes dorsalis," because the cervical enlargement of the spinal cord was chiefly involved, and those cases of syringomyelia in which the cervical enlargement was also chiefly or solely affected. In both cases changes in the hands or wrists might be the most obvious signs of the disease, but in syringomyelia the disease was most frequently localized in the cervical enlargement of the cord, whereas typical cases of "cervical tabes" were exceptional.

Carcinoma of Thyroid in a Boy aged 12.

By E. G. SLESINGER, O.B.E., M.S.

R. C., AGED 12, male. Father, mother, sister and brother healthy.

Born with very severe labour, weighing 14 lb. Deaf and dumb all his life. At 18 months operated upon for swelling over left mastoid and at 3 years for adenoids.

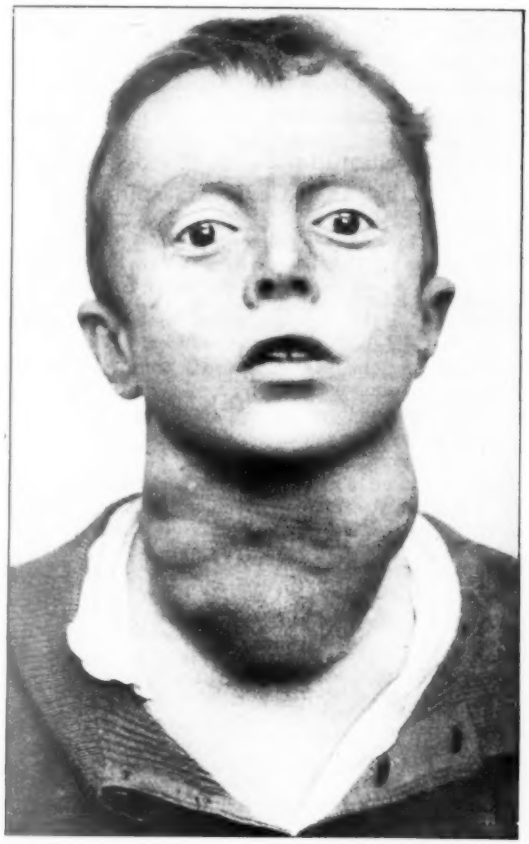
Has had a swelling of neck since birth and has been treated with thyroid throughout. Swelling did not increase until two years ago, when it grew rapidly. It is still growing, but is said to vary in size from day to day. At first it was smooth

Clinical Section 13

and uniform, but latterly has become irregular and nodular. Patient is very intelligent, and plays games, but suffers from stridor on much exertion.

He is short, but not dwarfed. No wasting. The hair is scanty, and the skin, especially of the hands and legs, is thick and dry. Writes very well and is bright and cheerful.

No glands can be felt in axillæ or groins and the spleen is normal. X-ray of



chest shows large root shadows and increased striation spreading to right apex.

On examining the neck the thyroid is seen to be enlarged and in addition there are numerous smooth, discrete swellings, apparently glandular (see fig.).

Blood-count.—Red cells, 4,070,000 per c.mm.; hæmoglobin, 83 per cent.; colour index, 1·02: white cells 12,800 per c.mm.; polymorphs, 42 per cent.; lymphocytes, 22·7 per cent.;

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large lymphocytes, 17·7 per cent.; primitive lymphocytes, 9·3 per cent.; mononuclears, 6·3 per cent.; eosinophils, 1·0 per cent.; premyelocytes, 0·3 per cent.; basophils, 0·7 per cent.

Basal metabolic rate normal. Patient's height is 4 ft. 2¼ in. and should be 4 ft. 9 in. for his age.

Mr. A. W. SHEEN said that in the case of an adult he would have considered the possibility of malignant disease of the thyroid with secondary growth in the glands. He had seen the glands similarly enlarged in the case of a female adult, in whom there was also a secondary growth in the skull.

Postscript.—Portion of thyroid and one of the superficial masses removed. These superficial nodules were glands with deposits of thyroid material. Dr. G. Nicholson reported the condition to be "basal-celled carcinoma of thyroid."

Deformity of Right Shoulder, with Associated Deformities of Ribs and Cervical Spine.

By W. E. TANNER, M.S.

E. K., SCHOOLGIRL, aged 13.

History.—Deformity of right shoulder since birth. Five other children aged respectively 14, 11, 9, 6 and 4, show no abnormalities.

Examination.—Right scapula rotated inwards and drawn upwards into the neck so that the superior angle forms a marked prominence, the contour of the neck is lost and there are associated deformities of the ribs and cervical spine. Scapula firmly bound to the spine by ligamentous bands. No elevation of arm; abduction restricted.

Treatment.—Patient shown for opinion as to treatment and particularly as to the propriety of a partial excision of the scapula to improve the arm movements and diminish the deformity due to the loss of contour on the right side of the neck.

Abdominal Tumour.

By F. D. SANER, F.R.C.S.

E. B., FEMALE, aged 36, married.

History.—Symptomless abdominal tumour. Noticed originally through increase in size of abdomen and diagnosed as pregnancy.

Examination.—Tumour now ovoid in shape and apparently cystic in certain areas. It extends obliquely across the abdomen from left of pelvis to right kidney region.

Mr. A. W. SHEEN suggested as a possible diagnosis lobulated retroperitoneal sarcoma which had insinuated itself amongst the mesenteries.

Postscript.—The patient was operated upon on November 13, 1926. The tumour was found to be a retroperitoneal lipoma extending from the lumbo-sacral region to the right flank, enveloping the kidney, with the capsule of which it was continuous. The mass was removed together with the right kidney; its weight was 7 lb. 2 oz.

Clinical Section 15

Diaphyseal Aclasia with Ulnar Nerve Weakness.

By N. L. ECKHOFF, L.R.C.P.Lond., M.R.C.S.Eng.

F. M., MALE, aged 16. Occupation, plaster modeller.

History.—Five months weakness of left forearm. Fall on to both wrists eleven months ago. Occasional pain at deltoid insertion, both arms.

Examination.—Curving of left forearm, with marked shortening of ulna. Wasting of muscles supplied by ulnar nerve, with weakness and fibrillary twitching. Slight anæsthesia over ulnar border of forearm.

Bony tumours at: (1) Insertion of deltoids—both arms; (2) lower end of femur and in both legs, upper end of tibia; (3) lower end of right tibia; (4) inner epicondyle, left humerus enlarged.

Electrical reactions of muscles normal. Skiagrams shown.

Discussion.—Dr. F. PARKES WEBER said that in place of Sir Arthur Keith's term "diaphyseal aclasis," he preferred the term "periosteo-osteo-dysplasia." The disease was essentially a faulty development or "dysplasia," sometimes familial, of the affected portions of the skeleton; the affected limbs were sometimes dwarfed; and occasionally one side might be alone or chiefly involved. In most cases, as in the present one, the distal extremity of the ulna failed to develop, but there were likewise (2) cases of multiple exostoses in which this characteristic defect of the ulna was not present, and also (3) rare cases in which the defect of the ulna could be demonstrated by Roentgen skiagrams, though no exostoses could be detected anywhere.[1]

Dr. KINGSTON BARTON remarked that during the past few years many cases of this condition had been shown before various Sections of the Society. Formerly they were called "multiple exostoses," but now the term "diaphyseal aclasis" was used. This new term had been suggested by Sir Arthur Keith in 1920, in an article describing his researches into this condition.[2] Since then there had been little added to our knowledge on the subject.

Case of Acrocyanosis.

By K. R. HAY, O.B.E., M.B.

MISS A., aged 26, Jewish tailoress.

History.—Born in London and has never been abroad. Father, born in Poland, and one brother are alive and well. Mother died of influenza in 1918, and one sister died, aged 6 years, of meningitis. No history of similar trouble amongst relations. Except for an attack of influenza in 1918 she has had no serious illness.

The trouble, which was first noticed at the age of 14, began as a swelling of the lower half of both legs and ankles, the skin in the region around and above the ankles being reddened and marked with scattered purplish areas; the condition has not altered materially during the last few years and there is no particular discomfort from it, except in cold or very hot weather when the legs ache and feel heavy on walking. Left leg rather larger than right, measuring about 18 in. at the top of the calf, and both knees and thighs appear abnormally developed. The skin over the legs pits with difficulty on pressure and is noticeably cold to touch around the ankles and feet. Patient states that her feet and hands usually feel cold. There are signs

[1] F. Parkes Weber, "Diaphyseal Aclasis or Periosteo-osteo-dysplasia (Multiple Exostoses) with Shortness of Forearms," *Proc. Roy. Soc. Med.* (Clin. Sect.), 1924, xvii, p. 40; also "A Developmental Deformity of the Right Forearm, similar to that sometimes met with in Multiple Exostoses," *ibid.*, 1925, xviii, p. 25.

[2] "Studies on the Anatomical Changes which accompany Certain Growth-disorders of the Human Body," *Journ. Anat.*, 1920, liv, pp. 101-115.

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of a chilblainy condition on the fingers, and the palms are damp and sweating. On the extensor surfaces of the arms there is a condition somewhat similar to that of the legs except for the skin discoloration. The general health is normal except that menstruation lasts one day and recurs regularly every six weeks. The hair is well grown and no sign of thyroid abnormality detected.

(The case was shown as one of trophœdema, but the diagnosis has been changed in accordance with the expressed opinion of the Section.)

Dr. F. PARKES WEBER said he thought this case was not "trophœdema," but one of persistent "acrocyanosis" of the extremities.[1] The moist, cyanosed, puffy hands, with tendency to chilblains in cold weather, were characteristic. The circulatory defect in the lower extremities during cold weather was obviously greatly increased by wearing short skirts and thin stockings.[2] In fact, the cyanosed chilblainy œdematous condition of the legs below the knees threatened to break down and leave open ulcers, and could even be confused with true tuberculous erythema induratum (Bazin's disease of young women). When the condition in the legs became very threatening there was nothing better to do than to keep the patient in bed for a few days, so that the even warmth and horizontal position might relieve the circulation in the otherwise dependent lower limbs. Amongst supposed predisposing causes were hypoplasia or imperfect function of the sexual organs (suggested in this case by the scanty menstruation), hypoplasia (developmental dysplasia) of the aorta and large arteries supplying the extremities, and defective action of the thyroid gland (thyroid treatment was almost always tried in such cases). It was doubtful whether intravenous injections of calcium chloride did any permanent good. The patients tended ultimately to "grow out" of the circulatory defect.

[1] F. Parkes Weber, "Case of Acrocyanosis," *Proc. Roy. Soc. Med.* (Sect. Derm.), 1926, xix, p. 70.

[2] F. Parkes Weber, "Two Diseases due to Fashion in Clothing; Chlorosis and Chronic Erythema of the Legs," *Brit. Med. Journ.*, 1925, i, p. 960.

Section of Comparative Medicine.

President—Sir D'Arcy Power, K.B.E., F.R.C.S.

Tuberculosis in Captive Wild Animals as Compared and Contrasted with the Disease in Man.

By H. Harold Scott, M.D., F.R.C.P.Lond., F.R.S.E., F.Z.S.

Tuberculosis is a disease of civilization. It is held by many that the *Bacillus tuberculosis* is ubiquitous, but evidence goes far to prove that this statement is erroneous, and that in places where the white man has not penetrated, the disease does not exist. This statement, again, needs a little qualification, for tuberculosis may be spread by natives returning to their dwellings after they have contracted the disease themselves by contact with white people, each of them then constituting a focus for further dissemination.

The human aspect of this subject has been dealt with in considerable detail in another place in a work devoted to questions of the health problems of the Empire; space and time forbid my repeating the evidence there adduced.

To the question: "Does Tuberculosis exist in Wild Animals under Natural Conditions?" one would reply emphatically in the negative, or, if one wished to be cautious, one might say that it is highly improbable. I have tried to find records of its existence, but can discover no data which as scientists we could consider reliable. The facts quoted from the Tuberculosis Commission Report: (1) That some of the monkeys received by them were already infected; (2) that Ebers had found the disease present in some wild swine which had been taken from a private preserve; and (3) that the disease occurs in pheasants, all count for nothing unless contact and association with domesticated animals or with human beings can be positively excluded. We must in fairness concede that evidence of tuberculosis amongst wild animals in a state of nature is hard to obtain, because, when a wild animal sickens, it is in most cases promptly killed by its companions and devoured by them or by scavenger birds.

In the case of wild animals in captivity there is, however, a very different tale to tell. In the first place, it is not always the fittest that fall into captivity, the healthiest either escape or are killed; those which are caught are either the very young, or those handicapped by sickness or injury, whose very incapacity has enabled their capture to be achieved—in other words, an instance of survival of the unfit.

Secondly, contact and association with their captors and attendants, unhygienic conditions of storage and transit, provide increased opportunities for communication of disease primarily, and the spread of it secondarily.

Thirdly, after arrival at their final destination where they can be carefully tended, with all the goodwill in the world, with careful and regular feeding, as good housing as is possible in the best supervised Zoological Gardens, the confinement necessarily leads in the majority of them to a lowering of general tone and vigour, enhanced by the *ennui* and lack of exercise which the hunting for food and stalking of their prey obviate under natural conditions. Also the lack of air and of the inestimable benefits of sunshine, all exert in their various degrees a detrimental effect upon the general health.

Since the human and the bovine types of the bacillus are those found to cause disease in man, they have naturally been studied in greater detail than the avian, piscine, or reptilian types.

Working, however, with animals in captivity as, for example, in the Zoological Society's Prosectorium, where birds comprise nearly half of the deaths investigated, the question of avian tuberculosis comes to occupy a more important place than

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either of the other types individually. In veterinary work avian tuberculosis is beginning to play a much greater part than formerly, and probably in human medicine also, the chances of infection by the avian organism are not so beyond the realms of possibility that the case can be summarily dismissed without even the customary caution.

Cases of infection by the avian strain have been reported in nearly all the domestic animals, and even in man. To some mammals it is but slightly infective, but to others—for example, the pig and the rabbit—the avian seems to be almost equally pathogenic with the bovine strain, though perhaps the disease resulting is of a milder type. In fact, from inquiries recently carried out in the United States, it is concluded that nearly nine-tenths of the cases of tuberculosis in pigs are to be ascribed to the avian bacillus.

We shall not be far wrong if we take it that all the types of tubercle bacilli found in the higher vertebrates *can* become infective for any member of the class. As examples we may mention that the parrot is regarded as being peculiarly susceptible to the bacillus in that it may suffer from tuberculosis caused by the human, bovine, or avian type; also that the human type of organism has been isolated from a duck. I am not, however, proposing to discuss tuberculosis in domesticated animals, and will confine my remarks to personal experiences obtained during the last two years in carrying out autopsies on animals dying at the Gardens of the Zoological Society of London.

It is remarkable that many animals not only live, but *may* remain to all appearances in good, and even in excellent, health, until shortly before death, although the disease is not only widespread in the body, but in an advanced stage, thus constituting a grave menace to other, healthy, animals in close contact with them. I could quote several instances of this, but two will be sufficient to illustrate the point, one amongst mammals, and one amongst birds.

(1) A Mozambique cercopitheque (*Cercopithecus rufoviridis*) was found dead one morning, nothing remarkable having been noticed in its health or behaviour on the previous day. At the autopsy there was no noteworthy emaciation, but the following conditions were revealed when the body was opened. Both lungs were in a state of broncho-pneumonic phthisis with cavitation in parts (the specimen is preserved in the Comparative Pathology Section of the Museum of the London School of Hygiene and Tropical Medicine), the pleurae were studded with tuberculous deposits, many of them caseated, the great omentum was peppered all over with milia, so also was the mesentery, but less thickly; the liver showed numerous deposits varying generally in size from milia to hempseed, but a few were larger. The spleen was three to four times the normal size and was thickly studded with caseated deposits up to the size of a pea. The head of the pancreas was converted into a single caseous mass (the bladder contained some urine, but no reduction of Fehling's solution occurred on testing). There were small tubercles in the left kidney; none were seen in the right; small tubercles were present on the outer surface of the wall of the bladder. The bronchial, infraclavicular, and mesenteric glands were much enlarged and caseated, the former breaking down and containing creamy pus. Smears were made from each of the above sites and acid-fast bacilli were present in all.

(2) An avian example. A grey-headed porphyria (*Porphyria poliocephala*) was found dead in the aviary. There was an abscess involving the left ear and extending forwards so as partly to cover the left eye. This was found to contain cheesy pus, revealing many acid-fast bacilli. The air-sacs, on both sides, posterior as well as anterior, were filled with tuberculous masses, forming almost a cast of the thorax; in the myocardium (this is, in my experience, uncommon) were two caseous masses. In the abdomen the disease was equally extensive. As already stated, the posterior air-sacs contained masses of cheesy deposit, the serous coat of the intestine throughout its length was covered with milia (more will be said on this later), and so also was the parietal peritoneum. No signs of any ulceration were seen when the intestine was opened. The liver was studded throughout with small caseated masses. The spleen was enlarged and nodular; the cortical region consisted of a mass of tuberculous

material, while in the interior were seen a few large and many small masses; small tubercles were seen in the cortical area of both kidneys.

From the characters of these lesions they must have been of some standing, and not the result of a generalization shortly before death, yet there had been nothing particular noticed as regards the bird's health or appetite.

In some animals, on the other hand—and this remark applies more particularly to mammals,—there is a rapid falling off in condition, a troublesome cough if the lungs are involved, an obstinate diarrhœa if the intestinal tract is infected, with a marked degree of emaciation, and the animal is mopy and listless; but this rapid deterioration of health is noticed in many only a few days before death.

We may say, speaking generally, first, that the disease in animals may reach an advanced stage without producing anything very noticeable in the way of symptoms, there being in many cases no marked emaciation, and the appetite remaining good up to the very last; secondly, that in them the generalization is greater than is usual in man: thirdly, that in the great majority of cases the development of the disease appears to be much more rapid. For this reason, perhaps, one practically never sees signs of healed tuberculosis in wild animals. They constitute a virgin soil, a non-immunized community, and when once the disease is introduced among them it will spread like a prairie fire, just as it does among a native race previously free from tuberculosis.

Primates, Carnivora, Rodentia, Aves, may each and all reveal at autopsy indications of heavy and widespread infection and yet show little or no emaciation and retain a good coat. It may be worthy of a passing remark that some mammals afford good examples illustrating this last point. Thus, in a lion, dead from tuberculosis, the mane was noticed to be exceptionally fine and silky; other mammals may also show a similar silky coat. May not this be analogous to the fine, soft, silky hair of the delicate tuberculous type in man? On the same lines, perhaps, is the wonderfully fine plumage exhibited by some tuberculous birds, surpassing even the splendour of their kind. This is particularly noticeable in gallinaceous birds. Even when emaciation is present, the colouring remains and the feathers so exuberant as to mask the loss of flesh, though, if actually weighed, the bird has clearly gone very light.

And again, we all know the fine reds and blues of the wattles and combs of some birds. We have noticed at the Zoological Gardens that even when the bird is obviously ill, wasting, moping, and showing other signs of disease, the comb and wattles often retain their brilliant colouring in tuberculosis. May we, perhaps, compare this with the fascinating, delicate, hectic flush of young people suffering from tuberculosis?

I will now discuss some striking differences between the symptoms and pathological findings in animals and those commonly met with in man. These are many, but I will call attention to a few only.

(1) *Hæmoptysis.*—This is a common symptom of pulmonary tuberculosis in man, but I have never seen it in wild animals, nor have I been able to obtain any history of it. Whether it occurs in domesticated animals I am not in a position to say. In some of those dying at the Zoological Gardens with advanced pulmonary disease, a true broncho-pneumonic phthisis with cavitation was present—I have seen it in mammals and a reptile, and one specimen at least is now at the Museum of the London School of Hygiene and Tropical Medicine—the symptoms were cough, emaciation, diarrhœa, and so on, but never hæmoptysis.

(2) *Cough.*—In some cases this is present, but not marked; in others it is distressing and persistent. In others, again, this symptom may be absent, although the pulmonary involvement is extensive. Moreover, when present, it is of little or no diagnostic value, for animals do not expectorate and a troublesome cough is often present without any tuberculosis, due, perhaps, to the inhalation of straw particles

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and seeds from the bedding. Its greatest value is that it leads one to examine the fæces for the bacilli as they pass through from swallowed sputum.

(3) *Brain Tuberculosis* is very rare in my experience, not yet a very long one, it is true, but I cannot find any records in previous reports, though these date back for many years. As a matter of fact, I can only recollect two during the last two years. In one of these there were very sparse milia in the meninges along the fissure of Sylvius, as part of a widespread generalization.

The second record, that a of sooty mangabey (*Cercocebus fuliginosus*), more than five years in the Gardens, is worth noting for the amount of involvement of the central nervous system. The dura mater was slightly adherent over the sagittal suture. There was an abscess as large as a split pea on the dura over the right motor area, and caseated milia over the temporal region of the right side and in the temporal fossa. There was no sign of any abscess in the cerebellar region. A few scattered milia were seen in the left parietal. There was leptomeningitis of the inferior frontal lobes on both sides. As regards the brain itself, there was a superficial abscess in the apex of the right temporal lobe as large as a hempseed, with hæmorrhage over the upper half of the arc. This was associated with extensive tuberculous meningitis over the temporal lobe. Lastly, and this is specially noteworthy, the pituitary was very prominent owing to a well-marked abscess in the sella turcica and occupying the lower half of the pituitary gland. There were a few milia in the upper half. Tuberculosis of this gland has been recorded in human pathology, but is, I believe, a rare phenomenon.

(4) The *Bones* and *Joints* would appear to be almost immune. The commonest exception to this generalization is found in the ribs in mammalian cases, in which I have found tuberculous abscesses on several occasions. In birds I have twice found the top of the sternum involved, in one case, that of an Amherst pheasant, there was a tumour as large as a fives ball with caseous contents and innumerable acid-fast bacilli. This also is in the Museum. It is a strange fact that, however extensively and densely the air-sacs may be involved, and even the lungs as well, I have not been able to demonstrate the bacilli in scrapings from within the long bones.

I have not yet met with a case of the Pierre Marie syndrome, which has been recorded as occurring in a non-pulmonary form in gallinaceous birds, and is said to be tuberculous in nature. Lassère, Ball and others, in their work on the tuberculous basis of this condition in the horse and large dogs, have shown that the Pierre Marie syndrome, known better, perhaps, by the more cumbrous name of hypertrophic pulmonary osteo-arthropathy and recognized for a long time in man, also occurs in large dogs, such as Great Danes and St. Bernards. Bacterial examination fails in this condition to reveal any tubercle bacilli—in fact, on this account Poncet brought forward his "théorie toxinaire"—but when an emulsion of the triturated bone-fragments was injected into guinea-pigs tuberculization resulted. I am not aware of any corresponding investigation in human cases.

(5) *Calcification*, though occurring not very uncommonly in man, in old caseous foci or in glands the seat of old-standing disease, is a late development in the human subject. In bovines, however, the condition is said to be relatively frequent, and, moreover, occurs early, in about three months from the time of onset of the disease.

(6) *Pus-formation*, the common state of tuberculous lesions in man, is comparatively rare in the tuberculosis of wild mammals, and in birds I have never seen it. In mammals—monkeys, for example—I have seen empyema resulting from extension of a pulmonary cavity to the pleura, or, more commonly, from the bursting of a broken-down bronchial gland. In birds, however, one may see an organ converted into a vast tuberculous mass or containing a large number of deposits, some isolated, others confluent. But they are in most cases firm, well-defined, caseous and fibro-caseous masses, not with creamy pus, but with brittle, cheesy contents and a fibrotic border.

It has been said that the principal and only significant routes of diffusion of tuberculosis are through the respiratory and alimentary tracts. This holds good generally for

mammals and birds, but not in the case of reptiles. It is true I have seen respiratory tuberculosis in reptiles, but quite as often it has presented itself as extensive, firm, cheesy and even crumbly calcareous masses in the subcutaneous tissues, the bacilli entering by the cutaneous route, and widely destroying the tissues beneath the scales, and, later, spreading through the muscles.

Speaking generally, we find that as regards the portal of entry the alimentary route is the more important in Primates and birds, for in the latter, at all events, the disease is largely spread by their swallowing material soiled by fæces containing numerous bacilli. In many mammals, also, the habit of putting everything into their mouths is, at least, a potential source of danger. In this there is a very close analogy between the monkey and the man-cub. The former struggle for food on a dusty bacillus-laden excreta-soaked floor, even seize it from each others' mouths to transfer it with soiled fingers to their own. Is the latter, the young of *Homo sapiens*, in much better case? We have summed up the matter in the following words taken from the article on "Tuberculosis" in "Health Problems of the Empire" (p. 265):—

"Old nurses with a chronic cough will persist in tasting the baby's food to see whether it is sweet or cool enough, and it has been proved that in the mouths of phthisical persons there are virulent tubercle bacilli, and, further, that in a large percentage of such cases, the spoons and table-utensils used by them are infective; attendants and so-called friends will kiss the baby on the mouth or will insert their fingers to feel for coming teeth; the mother or the nurse will feed the child with dainties from her own plate, using her own spoon: articles well covered with the infant's saliva are dropped on to the dusty floor, or in the street, are picked up and given back to the child, who again promptly returns them to its mouth. In short, the 'dirty age,' when everything within reach is inserted into the mouth, is the dangerous age as regards tuberculosis."

Other mammals, especially the ungulata, are more liable to infection by the respiratory route. It is, however, as we all know, not an easy matter to determine the primary portal of entry in every case. Feeding experiments have shown that the bacilli can reach the lungs by passing through the intestinal wall and by way of the lymphatics, leaving no gross lesions, and a definite decision as to the route is open to fallacy. Also, argument on the principle that the "oldest or best developed lesions occur where the originally settled organisms exerted their maximum effect" is again liable to mislead, while yet again the disease in many cases runs so rapid a course that it may be impossible to say which *is* the oldest lesion.

Other organs in which tuberculosis is frequently seen are the spleen and the liver. I have notes of some figures which I think were worked out by Dr. Herbert Fox. In these it is stated that in mammals the liver is found involved in 58 per cent., the spleen in 67 per cent.; in birds the liver in 80 per cent., and the spleen in 68 per cent. It is also recorded that in monkeys the spleen appears to be particularly susceptible, in fact, it is the high proportion of spleen tuberculosis in monkeys which constitutes a large factor in the percentage rate. So much so is this the case that a general tuberculous nodular involvement of the liver and spleen (associated, perhaps, with pulmonary disease) goes by the name of "monkey tuberculosis."

Sometimes, in addition to this splenic and hepatic condition, but equally often without, or with merely a few, deposits of the size of milia or hemp-seed, we find in monkeys a broncho-pneumonic phthisis, with cavity formation as in man, or a massive caseation like a tuberculous pneumonia. In monkeys, however, though several cases have occurred in the course of my autopsies at the Zoological Gardens, I have never observed the condition found in chronic pulmonary tuberculosis in man in which the vessels appear unsupported and aneurysmal in the cavity. In this connexion I may again refer to the absence of hæmoptysis as a feature in animal tuberculosis.

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Tuberculosis of the thyroid is a rare event (I speak of my own findings). I have twice seen miliary infection as part of widespread generalization, namely, in a Malbrouck cercopitheque (*Cercopithecus cynosurus*) and a common macaque (*Macacus fascicularis*); once a single deposit, the size of a hemp-seed, in a green cercopitheque (*Cercopithecus sabæus*); once, in a roughed lemur (*Lemur varius*), several small nodules, and twice a definite caseating mass as large as a pea. These last were seen in a common macaque and in a Schlegel's spider monkey (*Ateles pan*).

Myocardial deposits also are very rare; I have seen them only twice, although the pericardium may be extensively affected, usually by direct extension from the left pleura.

Glandular involvement is usually well marked in fairly early stages, and in the later stages the glands are converted into matted, caseated masses. Cervical gland tuberculosis is not common in those specimens I have examined, but bronchial and infraclavicular involvement frequently occurs. The mesenteric glands also are often a little enlarged and are found upon opening to contain a small bead of caseous pus. I have, however, on two occasions found masses of agglomerated, adherent caseous glands in the abdomen, resembling the tabes mesenterica of children.

Avian tuberculosis, as seen in wild birds (I presume it also occurs in domesticated birds, but of these I have no first-hand knowledge), presents certain marked differences from the disease as seen in mammals, and a few remarks on this point are therefore desirable.

(1) Instead of the usual condition of miliary or larger tubercles derived from an aggregation of smaller tubercles, with a breaking-down centre and a periphery verging into the surrounding tissue, we frequently find isolated nodules with a well-defined circumference. This outer limitation results from the formation of a fibro-cellular peripheral zone giving the appearance of a distinct capsule formation, an appearance which is emphasized by the fact that the tubercle can be enucleated, practically entire, leaving a cavity with a greyish lining. Moreover, the central area does not soften and break down, but is formed of a gritty, brittle, firm, almost chalky mass. In other words, we do not find anything resembling the softening to the extent of creamy pus production as is seen in mammalian cases. A possible explanation of this is, I think, of a twofold nature. First, infection with pyogenic cocci is a rare event in birds in any diseased condition, and so with tuberculosis; secondly, polymorphonuclear leucocytes do not form a large percentage of the white cells in avian blood; thus, normally in the fowl the percentage of polymorphonuclears and eosinophils together, is stated by various authors to vary between thirty and forty, and by the majority of observers to be nearer the former than the latter figure. Ellermann and Bang, who have probably done as much work on this question as any investigators, give twenty-nine for the leucocytes with spindle-shaped granules (the analogue of the finely granular neutrophil in man) and four for the spherical granular cell, which corresponds with the eosinophil.

(2) As noted by Dr. Fox, we not infrequently see a large central mass which has undergone a hyaline necrosis, apparently simultaneously, over a fairly large area; the condition is named "gelatinous tuberculosis," and is quite distinct from the slow necrosis of mammalian tubercles.

(3) Again, one may meet with tubercles attaining a considerable size without the occurrence of any necrosis or caseation in the central parts. On microscopical examination these are seen to be cellular throughout and may be denominated tuberculomata. Fox thinks them suggestive of the "perlsucht" of bovines. In none of the Bovidæ in which death has occurred from tuberculosis have I seen the pearl condition found in domesticated animals. It is only right, however, to state that few of this group have died from tuberculosis since I began work at the Prosectorium of the Zoological Society.

(4) Cutaneous tuberculosis is commoner in birds than in mammals. In reptiles, as already mentioned, the cutaneous portal of entry is not uncommon. The warty-looking growth seen in the neighbourhood of the eye in some birds—parrots for example—proved on examination to be tuberculous, as in the porphyria whose case was related earlier in this paper.

(5) Fox describes three forms of intestinal tuberculosis in Aves, and we have met with all of them during the last two years. (i) The bacilli would seem to have been brought by the lymphatic route to the subperitoneal tissue and to produce small nodules in the serous coat. It is possible, of course, that they have gained access to the serosa by penetration from the mucous surface, but the distribution, and the fact that the mucosa seems to be intact, are evidence in favour of the former hypothesis. (ii) Tuberculous ulceration of the intestinal mucosa showing no unusual appearance, and probably resulting from ingestion of the bacilli. (iii) A less common condition, occurring especially in the upper part of the bowel,—in the duodenum. The wall is thicker and tougher than normal, the mucosa appears healthy, and the villi are prominent, reminding one somewhat of the rubber mats with upstanding points which are seen in shops to facilitate the picking up of change. Microscopical examination reveals tubercle bacilli and a " diffuse cellular exudation in the villous stalk and the adjacent submucosa," and there may be prominent aggregations of lymphoid cells arranged follicularly. The serosa is intact.

There are other points of difference between human tuberculosis and the disease in wild animals, and differences also between that occurring in wild mammals and that in birds, but the above are the most important.

Lastly, the microscopical appearance of the tubercles as seen in different animal groups needs a brief description, for although the general principle as regards structure is the same in each, individual differences are considerable, though not always so definite as to be diagnostic.

Beginning with the miliary tubercle of the human disease, we find a more or less circular or spherical mass consisting of cells arranged roughly concentrically, each with pale cytoplasm and an elongated nucleus—the so-called epithelioid or endothelioid cells—with possibly a giant-cell in the centre of the aggregation, the processes of which extend between these epithelioid cells ; outside these again are a number of mononuclear, lymphoid cells, supported by a fine reticular tissue arising from fibroblasts. The capillaries and lymph-spaces originally present become obliterated and to the resulting deprivation of nutriment is ascribed the necrosis which ensues in the more central parts of the tuberculous nodule. Others hold that the necrosis is due directly to the effect of toxins produced by the bacilli. Very likely both processes participate, for if the capillaries are obliterated the tubercle in the earlier stages is but small and sufficient nutriment would probably enter by absorption.

At a more advanced stage, which even the more recently formed tubercles have usually reached at the time that microscopical examination becomes possible, the central necrosis is as a rule complete, giant-cells are present and endothelioid cells abundant, the lymphoid layer being, in human cases, narrow in proportion ; the epithelioid cells are most striking.

In bovines, the epithelioid cells are abundant, but they appear to be smaller than in man ; the small round lymphoid cells are not very numerous, but giant-cells are prominent ; the connective tissue is relatively more marked and caseation and even calcification are liable to occur early.

In dogs—in the domesticated animal, at least—giant-cells seem to be conspicuous by their absence. Some authorities state that giant-cells are always absent in canine tuberculosis. My experience in this respect is not sufficient to warrant an expression of opinion. I may here mention, incidentally, the peculiar condition met with in the

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liver of tuberculous dogs which has been given the name of "atypical tuberculosis" of the dog. Nodules varying in size from a few millimetres to several centimetres are seen, having a wavy outline and a very congested periphery. They may become umbilicated as the result of sinking or contraction due to the central necrosis, and are therefore not uncommonly confused with neoplasms. Microscopically, the histological findings are typical, the larger nodules being composed by the confluence of small tubercles, hence the designation "atypical" is applicable to the macroscopical appearance only.

In monkeys, giant-cells are usually present, but they may be exceedingly scarce, in fact, in some parts, absent. The epithelioid cells are large and often of a syncytial type. Central necrosis seems to extend rapidly, the peripheral reaction is very slight and the round-cell accumulation is relatively narrow and little noticeable. In fact, we have all the characteristics of an inflammatory focus of rapid growth.

Lastly, in birds, we find a peculiar disposition of the multinucleated cells such as I have not noticed in any other group. They may constitute an almost complete ring of large cells with the nuclei placed at the outer part, as at the convexity of a horseshoe, or like a palisade of syncytial cells with radiating columns of nuclei, more or less, and often more than less, completely surrounding the area of central necrosis which is thus sharply defined. The agglomeration of epithelioid cells external to these is generally rather scanty, as are also the lymphoid round cells. The connective tissue development outside this, however, is very prominent, and it is probably due to this that the cheesy, or more often cretaceous, core is so easily shelled out.

By the kind permission of Dr. Andrew Balfour, the Director of the London School of Hygiene and Tropical Medicine, I have been able to bring some specimens deposited in the museum there from cases which I have met with in the course of my work as pathologist to the Zoological Society, illustrating some of the points which have been referred to in the foregoing paper, and a few slides demonstrating some of the microscopical appearances of the disease in wild animals.

Dr. KINGSTON BARTON said he was interested in hearing from Dr. Scott that quite rarely secondary growths of tuberculous tumours were found within the heart walls of a mammal. Dr. Barton had recently met with a case where several very large tuberculous tumours were found within the wall substance of a heart, in a Siamese youth, who had died rather suddenly whilst suffering from what was diagnosed as a general tuberculosis within the thorax. This case also reminded him (Dr. Barton) of points mentioned by Dr. Scott that, in some animals the secondary tumours of tuberculous growth were quite free from any signs of even a threatening suppuration, but rather of a simple fibrous nature. The first microscopist who cut sections of these swellings removed from the Siamese youth, reported that they might be gummata, and even ventured to suggest they were due to "yaws." However, when the heart and its tumours, and other material from the thorax, were submitted to the pathologists at St. Bartholomew's Hospital, and the clinical history was explained, they had no doubt whatever that the swellings were simply large masses of non-suppurative, tuberculous growth. This Siamese youth in some of his habits imitated the life of those animals who carried on with their active life close up to their end, in the way to which Dr. Scott has drawn attention. The patient, having led for several years quite a normal life of a hard-working law student, declining to admit that he was ill, and being able to eat and digest all normal foods, appeared to look very well. It was only after passing all his examinations for the bar that he submitted to be overhauled, when a very serious state of disease was discovered within his thorax.

Concerning the different types of tuberculosis found in birds, cows, pigs, horses, &c., mentioned by Dr. Scott, he (Dr. Barton) suggested that the special type existing in birds might be due to the very high blood-temperature that was normal to them.

Section of Epidemiology and State Medicine.

President—Dr. S. Monckton Copeman, F.R.C.P., F.R.S.

The Hospital in Relation to the Public Health.

By George F. Buchan, M.D., D.P.H.

(Medical Officer of Health, Willesden.)

Twenty years ago if I had been asked to read a paper on this subject my remarks would have been confined to the place of the isolation or infectious diseases hospital in public health administration, but to-day the problem is much wider. Public health includes many services, and the hospital in relation to public health has to be viewed in the light of its utility relative to these services. In order to visualize the extent to which the hospital provision is necessary for public health purposes I propose to consider the beds required by an average community of 100,000 inhabitants, in which the birth-rate and death-rate are the average for England and Wales.

(*A*) Infectious Diseases.

In 1889, when the Infectious Diseases (Notification) Act was passed, the term "infectious diseases" included only small-pox, cholera, diphtheria, erysipelas, scarlet fever, typhus fever, typhoid fever, puerperal fever, relapsing fever and continued fever. To-day the additional notifiable diseases are acute polio-encephalitis, cerebro-spinal fever, encephalitis lethargica, poliomyelitis and acute poliomyelitis, puerperal pyrexia, ophthalmia neonatorum, acute primary pneumonia and acute influenzal pneumonia, trench fever, dysentery, malaria, plague and tuberculosis.

A disease is made notifiable so that information may be at once forthcoming as to its existence and steps taken for the prevention of its spread. These include the isolation of the sufferer, which is insufficient unless there is provided with it adequate means for the recovery of the patient. Hence hospital accommodation on an isolation or pavilion plan has been provided by public health authorities for the commoner notifiable infectious diseases, i.e., the diseases notifiable under the Infectious Diseases (Notification) Act, 1889, with perhaps the exception of puerperal fever.

Diseases Notifiable under the Act of 1889.—As a result of experience it has been found that for the diseases notifiable under the Act of 1889 one bed per 1,000 of the population is sufficient, and therefore for a community of 100,000 persons 100 beds for these diseases should be available.

Since 1889, however, as already stated, other conditions have become notifiable and hospital provision requires to be made for them in the same way as for the diseases notifiable prior to that date.

Epidemic Diseases of the Central Nervous System.—The number of these diseases notifiable annually in an average community of 100,000 persons is estimated at eight on the basis of known returns. It may be accepted that the majority of cases notified require hospital accommodation more on account of the special treatment necessary than by reason of the infectiousness of the complaint. If it is assumed on the basis of the Willesden experience that the average duration of hospital in-patient treatment for these cases is thirty-five days then one bed is required for every 100,000 of the population.

The epidemic diseases of the central nervous system are acute polio-encephalitis, cerebro-spinal fever, encephalitis lethargica, poliomyelitis and acute poliomyelitis. Their inclusion amongst notifiable diseases presents a new problem in the provision of hospital accommodation by local authorities on account of the special and prolonged in-patient and out-patient treatment required for these diseases.

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Puerperal Fever and Puerperal Pyrexia.—The 1926 Regulations requiring notification of these diseases impress on local authorities the need for the provision of hospital accommodation. In an average population of 100,000 persons six cases of puerperal fever are notified per annum. The number of cases of puerperal pyrexia likely to be notified under the new regulations is problematical, but such number would not greatly increase the number of beds required for puerperal fever and puerperal pyrexia. Having regard to the fact that six cases of puerperal fever are notified per annum and that the average stay in hospital of a case of puerperal fever, based on Willesden returns, is six weeks, one bed would appear to be ample provision for both these conditions.

The hospital treatment of puerperal fever requires special skill and equipment, and alters the character of the hospital provision hitherto established by local authorities for public health purposes.

Ophthalmia Neonatorum.—This disease has been notifiable since 1914. The 1926 Regulations bring into prominence the need for hospital accommodation in a proportion of these cases for purposes of adequate treatment and the prevention of blindness. The number of cases of this disease likely to be notified in any one year in an average community of 100,000 is eighteen. Provided that adequate home nursing arrangements are in operation in the area only a comparatively small proportion of these cases would require hospital treatment. The duration in hospital of a case of ophthalmia neonatorum is not likely to exceed one month on the average, and the provision therefore of one bed is more than ample for this condition in a community of 100,000.

Here, again, specialist treatment may be required, and the compulsory notification of this disease makes it still further necessary for local authorities to review the character of the hospital accommodation to be provided for their work of public health.

Acute Primary Pneumonia and Acute Influenzal Pneumonia.—The notification of these diseases became operative in 1919. The number of cases of acute primary pneumonia likely to be notified in the average community of 100,000 in any one year is 124. The number of cases, however, of acute influenzal pneumonia which may be notified will vary greatly, according to the prevalence of influenza. If it is assumed that a case of acute primary pneumonia admitted to hospital would remain there on the average for a period of four weeks, the number of beds required for acute primary pneumonia would be four, on the assumption that 40 per cent. of the cases notified were admitted. The experience in Willesden is that 41·1 per cent. receive hospital treatment. If the same number of beds is added for acute influenzal pneumonia, making a total of eight beds for these conditions, the needs of a population of 100,000 would appear to be reasonably met.

The inclusion of these diseases in the list of notifiable diseases does not raise any new problem of hospital accommodation, as special methods of treatment for them are not generally required.

Trench Fever, Dysentery, Malaria and Plague.—The number of cases of these diseases which are notified annually in this country is so small that the provision of hospital accommodation for them as a problem hardly arises.

Tuberculosis.—The number of new cases of pulmonary and non-pulmonary tuberculosis which are likely to be notified in any one year in a community of 100,000 is 182 and the number of deaths arising from these conditions is likely to be 110 per annum. Experience shows that on the average a provision of one bed per 1,500 of the population for tuberculosis cases is sufficient, and sixty-six beds for this disease is the provision that should be made for a community of 100,000 people.

The inclusion of tuberculosis as a notifiable disease has raised many new problems in regard to hospital accommodation, including the situation of the hospital, the

separation of different types of cases and special forms of treatment. For these reasons as well as for the reason that the Tuberculosis Authority is not generally the Sanitary or Infectious Diseases Hospital Authority the provision of sanatoria and hospitals for tuberculosis has unfortunately been considered as a problem separate from the general problem of the hospital in relation to the public health. Tuberculosis is an important public health problem. It is not primarily a sanatorium or hospital question and cannot properly be divorced from general health work. We shall be no nearer a correct perspective relative to this and other important health questions if the present proposals in regard to the transfer of the Poor Law become operative before health authorities are so unified that they are able to survey all health problems, including hospital provision, in their areas singly and collectively, and especially in relation to one another.

(*B*) Maternity and Child Welfare.

The Maternity and Child Welfare Act of 1918 enabled local authorities to make such arrangements as may be sanctioned by the Ministry of Health for attending to the health of expectant mothers, nursing mothers and children under 5 years of age. Under this Act the Ministry of Health have indicated that they are prepared to sanction :—

(I) Hospital treatment for complicated cases of confinement or complications arising after parturition or any case in which the woman to be confined suffers from illness or deformity, or for cases of women who cannot with safety be confined in their own homes ; and

(II) Hospital treatment for children under 5 years of age found to need in-patient treatment.

Women.—With regard to hospital provision for complicated and uncomplicated cases of confinement it should be noted that the average number of births which occur per annum in a community of 100,000 in England and Wales is 2,000. In Willesden, where hospital provision has been made for these cases since 1918, it would appear that approximately 20 per cent. of all confinements would be most suitably accommodated in hospital. If it is assumed that each case on the average is in hospital for a period of a fortnight then sixteen beds would be required for complicated and uncomplicated cases of confinement in a population of 100,000.

Children.—With regard to children under 5 years of age in need of hospital treatment, the hospital provision necessary is more problematical. During the years 1919-1922 children in need of in-patient treatment were admitted to the Willesden Municipal Hospital under an arrangement approved by the Ministry of Health. During this period 991 cases were admitted. These cases included such conditions as prematurity ; atrophy, debility and marasmus ; diarrhœa, gastritis, gastro-enteritis and enteritis ; throat, nose and ear diseases ; bronchitis and broncho-pneumonia ; rheumatism and chorea ; phimosis and paraphimosis ; septic wounds ; deformities including talipes, cleft palate, &c. ; skin diseases ; hernia ; rickets ; &c.

This list of conditions is not exhaustive and it is therefore safe to say from this limited experience that the minimum number of children under 5 years of age requiring in-patient treatment under a maternity and child welfare scheme in any one year in a community of 100,000, based on the maximum number admitted to hospital in Willesden in any year, namely 324 in 1919, would not be less than 211. The average duration of stay in hospital of cases of these diseases was found to be three weeks and the minimum number of beds required for children under 5 years of age in a population of 100,000 may therefore be put at twelve beds. Probably considerably more would be necessary.

(*C*) School Medical Work.

The Education Act of 1921 requires the local Education Authority to make or secure such adequate and suitable arrangements as may be sanctioned by the Minister of Health for attending to the health and physical condition of children educated in public elementary schools. It is the case that this Act does not specifically mention hospital treatment, but equally it does not specifically mention any other form of treatment.

During the years 1919-1922 the Board of Education sanctioned the hospital treatment of Willesden school children. During the period the scheme was in operation there were admitted to the hospital provided by the Willesden local authority 1,528 cases of school children requiring in-patient treatment. On the basis of the maximum admitted in any one year, namely, 570 in 1920, and on the ascertained average duration of stay of fourteen days for these cases it would appear that thirteen beds would require to be provided for them in the average community of 100,000.

The conditions for which school children were admitted to hospital in Willesden included throat, nose and ear diseases, bronchitis and broncho-pneumonia, pleurisy and empyema, rheumatism, chorea, endocarditis and pericarditis, septic wounds and abscesses, deformities due to rickets, paralysis, &c., skin diseases, hernia, appendicitis, strabismus, corneal ulcer, conjunctivitis and other eye diseases, nephritis, &c.

Hospital provision for complicated and uncomplicated conditions of confinement or those arising after parturition, and for the treatment of children under 5 and school children suffering from the various diseases mentioned, implies not only the provision of the number of beds stated but that these beds shall be under the care of a specialized personnel, for a large proportion of the cases referred to enter hospital for special treatment.

(*D*) Venereal Diseases.

The number of new cases of these diseases which, on the average, may be expected to come under treatment in any one year in the average community of 100,000 is 151. Only a small proportion of these cases require hospital accommodation and on the basis of the provision for London and the Home Counties three beds would probably satisfy the needs for hospital treatment of these patients. Here again the provision by local authorities of beds for venereal diseases implies an adequate and specialized staff for the treatment of the cases.

Further Public Health Problems.

The foregoing statement shows that for the above purposes for which a local health authority may make hospital provision 221 beds are required for a population of 100,000. The consideration, however, of the number of hospital beds for public health purposes would be incomplete unless reference were made to some of the public health problems which are now pressing upon us.

(1) Measles.

This disease was compulsorily notifiable in England and Wales during the four years 1916-1919, notification being limited to the first cases occurring in a household seen by a doctor. During that time 1,565,380 such primary cases were notified and there were 29,567 deaths. In our average community, then, we are entitled to assume that on the average there would occur per annum at least 1,137 such primary cases and that there would be twenty-one deaths.

It is doubtful whether it is desirable to contemplate hospital provision for the isolation of all cases of measles, but there is no question as to the desirability of

providing hospital accommodation for severe complicated cases and also for cases where the home conditions of overcrowding and ill-ventilation predispose to pulmonary complications. If it is assumed that each case of measles removed to hospital is in hospital for four weeks and that the number of cases in need of hospital treatment will be at least four times the number of deaths it would appear necessary to provide seven beds for measles for a community of 100,000 people.

(2) WHOOPING-COUGH.

This is another disease which, like measles, causes many deaths. During the years 1921-1925 there occurred in England and Wales 25,149 deaths from whooping-cough as compared with 5,556 deaths from scarlet fever and 16,844 deaths from diphtheria. Whooping-cough in its complications and end-results is a disease very similar to measles and the same basis of calculation as to the number of beds required for cases of whooping-cough shows that in our average community of 100,000 persons four beds would be required for cases of this disease. Having regard, however, to the longer period of infectiousness in the case of whooping-cough as compared with measles it would appear desirable to make a greater proportionate provision for cases of whooping-cough and it is accordingly suggested that seven beds should be also reserved for this disease.

(3) ORTHOPÆDIC CASES, RHEUMATIC FEVER AND RHEUMATIC HEART DISEASE, AND CANCER.

At the present time public health provision for these conditions is under consideration by many experts, local authorities and committees. It is generally considered that the conditions could be largely prevented, or the crippling effects of the conditions largely reduced or life prolonged, by suitable public health provision which would include clinics for diagnosis, advice and after-care, and hospital accommodation for early treatment.

(a) *Orthopædic Cases.*

The local authority has recently been urged to make provision for these cases. Orthopædic cases result from paralysis due to various causes, tuberculosis of the bones and joints, congenital deformities such as club-foot, rickets and miscellaneous conditions such as rheumatism.

The progress of medicine has helped us as to the prevention of some of these conditions, such as rickets, but our knowledge has not yet reached the stage when measures can be taken for the prevention of acute poliomyelitis and some of the other conditions producing deformities. Recent advances in surgery, however, show that it is possible to do much to mitigate the crippling effects, and authorities have therefore been urged to take action to reduce these effects to a minimum.

An inquiry into crippled cases in Willesden showed that the number of crippled children under 16 years of age was approximately 1 per 1,000 of the entire population. This means that in our community of 100,000 there would be 100 crippled cases under 16 years of age. All of such cases would not require in-patient hospital treatment in any one year, but on the assumption that 25 per cent. of them were in-patients, each for a period of eight weeks on the average, then four beds would be required. It should be noted that the basis of this estimate is empirical, and the estimate itself must be regarded as provisional, pending experience.

(b) *Rheumatic Fever and Rheumatic Heart Disease.*

The Registrar-General's returns show that the number of deaths from these diseases occurring in England and Wales in 1924 was 57,832, and on this basis the number of such deaths in our average community of 100,000 would be 149.

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Rheumatism is a disease of childhood and adolescence. The mitigation of the disabling effects of rheumatism can be largely circumvented by the provision of hospital beds at a sufficiently early stage of the disease. The large number of deaths from rheumatic fever and rheumatic heart disease, and the amount of disablement that arises for some years preceding death on account of heart disease, justify a considerable expenditure in hospital provision for these conditions.

Here again I am unable to find any actual figures or experience to guide me in the provision of hospital beds for these rheumatic and heart conditions, and so my estimate must be based on theoretical and perhaps disputatious considerations. Some cases suffering from heart disease would probably succumb to some intercurrent malady, but for purposes of estimation of hospital provision required it may be assumed that the 57,832 deaths recorded above were the total deaths of persons suffering from these rheumatic and heart diseases. If it is assumed that these persons had been suffering from rheumatic and heart diseases for a considerable period preceding death, perhaps as long as twenty-five years on the average, it is probably correct to say that a total of one year during this period should have been spent in hospital under treatment in order to prolong life to its utmost limit. Six beds for rheumatic fever and heart disease should therefore be provided for a population of 100,000.

(c) *Cancer.*

The vital statistics of England and Wales show that 48,653 deaths from cancer occur yearly in England and Wales. The investigation carried out at Leeds in respect of cancer of the breast shows that early operation greatly prolongs life. If the operation is performed before the disease has extended from the breast 87 per cent. of the cases are alive at the end of ten years, but if the disease has advanced when operation is ventured upon only 5 per cent. or 6 per cent. of the patients are alive at the end of ten years. Such figures give a very clear indication of the great need for provision for the early treatment of cancer in all cases in which the region affected permits of operation.

The number of hospital beds required for cancer cases is, however, again problematical. Assuming that 50 per cent. of the cases recorded as dying from cancer were operable and came for operation at a sufficiently early stage, the duration in hospital of these cases generally would be four weeks. Therefore, in our community of 100,000 persons, five beds for cancer would be required.

It is likely that some hospital provision would also be required for the remaining 50 per cent. during the later stages of the disease, but this provision for dying cases is not particularly a problem of public health or preventive medicine. It is also likely that already most of these cases find their way to the hospitals of Boards of Guardians, and I do not therefore propose to consider them in relation to the provision of hospital accommodation for public health purposes.

(4) Total Beds Required.

The Annual Report of the Chief Medical Officer of the Ministry of Health for 1924 shows that the following hospital accommodation exists in England and Wales:—

	Total No. of beds	No. of beds per 1,000 of the population.
Isolation hospitals	37,351 ...	1·0
Tuberculosis hospitals and sanatoria ...	22,143 ...	0·6
Total ..	59,494 ...	1·6
Poor Law hospitals	120,278 ...	3·0
Total ...	179,772 ...	4·6
Voluntary hospitals	50,460 ..	1·4
Total ...	230,232 ...	6·0

An inquiry into the number of hospital beds provided for Willesden in 1926 resulted as follows :—

	Total No. of beds	No. of beds per 1,000 of the population
Isolation hospitals	147	0·9
Tuberculosis hospitals and sanatoria ...	88	0·5
Total ...	235	1·4
Poor Law hospitals...	430	2·4
Total ...	665	3·8
Voluntary hospitals	216	1·2
Total ...	881	5·0

The population of Willesden also makes use of London voluntary hospitals.

Dr. Picken, Medical Officer of Health of Cardiff, in a paper recently addressed to the League of Nations has stated that in Glasgow the total number of hospital beds provided, including Poor Law hospital accommodation but excluding beds for communicable diseases, is approximately 6 per 1,000 of the population. If 1 per 1,000 is added for purposes of communicable diseases then Glasgow is provided with about 7 beds per 1,000 of its population.

Dr. Picken also states that as a result of his inquiries in Denmark he ascertained that in the municipalities of Copenhagen and Frederiksberg the total number of beds provided in 1921 was 5,463 for a population of 666,159 persons, or 8·3 beds per 1,000 of the population.

With regard to our community of 100,000, a summation of the foregoing statement shows that 250 hospital beds are required to deal with matters of public health importance, or 2·5 beds per 1,000 of the population. According to the Annual Report of the Chief Medical Officer of the Ministry of Health 1·6 per 1,000 of these beds are already provided in isolation and tuberculosis hospitals and sanatoria, and therefore considerable additional provision in England and Wales requires to be made. Having regard to the Danish and Glasgow figures an addition of 1 bed per 1,000 of the population would appear to be a minimum for public health purposes.

(5) Character of the Beds Required.

It will be observed from the foregoing considerations of the conditions for which additional hospital accommodation is required that hospital provision different in certain characteristics from that hitherto established by local authorities will have to be made. The hospital accommodation which has now to be provided for public health purposes is, in fact, of the nature of the general and special hospital beds provided by the voluntary, general and special hospitals throughout the country.

(6) Method of Provision of Additional Beds.

Before steps are taken towards this provision it may be advantageous to discuss whether local authorities should proceed to erect hospitals, if they have not already provided any, or extend the hospitals already in their possession, or assist the extension of existing voluntary hospitals.

The provision of hospital accommodation in relation to public health is so important that I hope the question will not be further complicated, as is suggested, by the transfer of State-aided and rate-supported beds from boards of guardians to another authority which is not always the authority for the consideration of these public health problems involving extension of hospital accommodation. The suggested transfer will not unify hospital accommodation but will still leave it under as many authorities as before. It would be just as easy to establish a single health authority for a suitable area as to transfer duties from one inappropriate authority to another,

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while the establishment of the single authority would greatly simplify public health administration and the question of the provision of the necessary hospital accommodation.

Having regard to the fact that there are already provided in this country 179,772 beds by local authorities and 50,460 beds by voluntary hospitals, the question of the erection of new hospitals by local authorities will seldom arise. We are therefore limited for practical purposes to the discussion of questions of extension of Isolation Hospitals, Poor Law Hospitals and Voluntary Hospitals.

If I may be allowed to assume that the Poor Law Hospital has been transferred to the local health authority for the area, then I do not think that the solution of the problem is a difficult one. For reasons of administration, extension should be undertaken at the largest hospital, whether Isolation, Poor Law or Voluntary, in the area.

Doubtless there are those who consider that on medical grounds the so-called infectious or notifiable diseases hospital should not be extended to include general, medical and surgical diseases, and that infectious and non-infectious cases should not be housed on the same site. Such a view appears to be opposed to the general principle on which the isolation or pavilion hospital has been established. For if such a tenet is accepted it follows that a scarlet fever pavilion should not be on the same site as a diphtheria pavilion, particularly when the increased susceptibility of a scarlet fever patient to diphtheria is borne in mind.

The experience of other places is also against the dogma. The City of Amsterdam has a hospital of 1,500 beds on a site of twenty-two acres, which deals with general medical and surgical cases, mental cases, tuberculosis cases, venereal cases, obstetric and gynæcological cases, ophthalmic cases, orthopædic cases, and fever cases including smallpox, 456 of the 1,500 beds being set aside for the so-called infectious diseases. There is some separation of the living quarters of the nursing staff for fever and smallpox cases, but Dr. Kuiper, who has been Medical Superintendent there for thirty-three years, informs me that his experience has taught him that infectious diseases are never brought from one department to another, even when smallpox cases are in the hospital.

Again, in Denmark all the smaller municipalities such as Aarhus with a population of 60,000, and Svendborg with a population of 20,000, have one hospital for the town, for all conditions including infectious diseases, and no ill-effects result.

My own experience accords with that of medical officers on the Continent. In Willesden during the four years 1919 to 1922, there were treated at the Willesden Municipal Hospital, which is a hospital built on the pavilion system, 1,617 cases of maternity and diseases of women, 1,541 cases of school children, 1,018 cases of children under five years of age, and 260 cases of general diseases of adults, as well as 4,590 cases of infectious diseases, or 9,026 patients in all, without infection spreading from the one side of the hospital to the other. The nurses on duty were always kept to their separate pavilions and there was no communication between the nurses on duty in one pavilion and those in another; but off duty the nurses mixed freely together in the dining and recreation rooms. With these experiences before us it seems almost unnecessary to state that there is no medical reason why a hospital suitably planned on the pavilion system should not admit all the diseases for which a local authority may make provision.

Again, there may be those who would argue in favour of special hospitals for special categories of disease as opposed to the large general hospital with its necessary special departments. I am one of those who favour the latter. It does not seem to me to matter much whether special hospitals are erected on separate sites at considerable distances apart, or whether there is one large hospital with its special

departments erected on a site of a suitable size so far as the care of the patients is concerned. But multiple hospitals mean multiple equipment and increased cost of administration with, to some extent, loss of efficiency because of that lack of interchange of ideas and opinions, both generally and in respect of individual patients, between a medical staff engaged in different forms of medical work under a common roof. Another advantage of the single general and special and infectious diseases hospital is that a definite economy in the number of beds to be established can be effected as diseases are not all prevalent at once, and wards generally set aside for one disease may therefore be utilized from time to time for other diseases when not required for their normal purpose.

It is on these grounds that I am strongly of opinion that the large hospital on a sufficient site with the various necessary sub-departments is the best arrangement.

(7) Legal Powers.

Power is given to local authorities under Section 131 of the Public Health Act, 1875, to build hospitals for the reception of the sick inhabitants of their district. This power is extended by Section 64 of the Public Health Act, 1925, to include power to make reasonable subscriptions or donations to a voluntary hospital if the local authority are satisfied that by so doing they will maintain or extend or increase the efficiency of hospital accommodation for the sick inhabitants of their district. It is under these powers that a local authority would proceed to extend their own or a voluntary hospital in their area. Which of these two courses they will take will no doubt be determined by the views of the authorities concerned on the relative merits of voluntary or municipal enterprise. Most British graduates in medicine are of opinion that there could be nothing better than the large voluntary hospital. This is probably because it was in the voluntary hospitals that they were trained and initiated into the art and practice of medicine and surgery, but it would be equally well to remember that great efficiency exists in the isolation hospitals of local authorities. I may also add that as a result of my own observations in Denmark made during the present year, I can safely say that the Danish State Hospital and the Municipal Hospital at Copenhagen, with 1,000 and 700 beds respectively, are as efficient in respect of equipment and staff as are the best examples of the voluntary hospital system in this country.

(8) Staffing.

It will be obvious from the many and various conditions that require to be treated in the Public Health Hospital that no single medical practitioner will be able to cope with them. The Public Health Hospital, resulting from an extension of hospitals now in the possession of local authorities or of voluntary hospitals, could best be staffed on the same principles as a large voluntary hospital with specialists in charge of the departments and a sufficient number of resident medical officers for clinical purposes, the general administrative control of the hospital being vested in a medical superintendent.

With a hospital staffed on this basis it would be possible for resident medical officers entering the hospital service of an authority to make it a career either for hospital administration or for specialism in one or other of the departments, or to utilize the appointment as a preliminary experience for general practice.

In Copenhagen, where there is a State hospital for general and special conditions and a separate infectious diseases hospital for infectious disease, the heads of the principal departments including the hospital for infectious diseases are appointed as University professors. This arrangement is excellent and should be borne in mind in connexion with extension of hospital accommodation for public health purposes.

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Indeed such an arrangement might, with advantage to medicine and the medical student, be operative forthwith, for there is ample material in all city isolation hospitals for medical tuition and study. Any arrangement made for hospital accommodation for public health purposes should include an arrangement by which the hospital is available for study, and, if possible, practice by all medical practitioners in the area.

(9) Public Health Research in Relation to the Hospital.

The main function of public health is the maintenance of health and the prevention of disease. In a large general voluntary hospital much laboratory research is undertaken, and would equally be undertaken by a hospital provided or extended for public health purposes. But the form of research especially connected with public health is that which inquires into the antecedents of patients who arrive at the hospital in conditions of ill-health. Some effort should really be made to trace back these conditions so that the factors influencing their production may be ascertained, and, if possible, removed. That form of research, again illustrated by the work recently undertaken in Leeds in relation to cancer of the breast, as to the post-operative longevity of patients is another form of research that is likely to bear fruit. Such research should indicate the results of treatment while the necessary concurrent investigations into the post-hospital conditions of the patient should throw light on the extent to which they hinder complete recovery, determine relapse, or accelerate the known sequelæ of the disease. This may be called public health research in relation to the hospital. It is just as useful and as likely to benefit mankind as the research more commonly and more easily undertaken and necessarily involving chemical, pathological and animal experimentations. I am sure that the kind of inquiry I have indicated, starting from the hospital as a basis, would elucidate many of the causes directly or indirectly contributing to disease and thus be the means of promoting public health.

Discussion.—Dr. J. D. Rolleston observed that the inclusion of pavilions for infectious diseases in the grounds of a hospital for other diseases was the practice in all the children's hospitals in Paris, where it was only the adults suffering from infectious diseases who were isolated in special hospitals, such as the Hôpital Claude Bernard and Hôpital Bastion at Aubervilliers, just outside the fortifications. The same practice of having special pavilions for infectious diseases held good in other children's hospitals on the Continent. The advantage of this was that the best men had an opportunity of devoting their attention to the study of infectious diseases, as had recently been shown by the admirable work on immunization against acute infections done by the staff of children's hospitals on the Continent to which Dr. Monckton Copeman had alluded in his Presidential address.

On the other hand, he (Dr. Rolleston) pointed out that there were plenty of opportunities for studying most branches of medicine, especially epidemiology, pædiatrics and medical history in large isolation hospitals, and he regretted that so few of the medical staff of the fever hospitals in this country, especially in London, were Members of the Section.

Dr. Janet Lane-Claypon asked Dr. Buchan whether there was in Willesden an actual shortage of hospital accommodation at present, or whether that provided by the existing 5 beds per 1,000 was sufficient? Theory and practice were not always consonant.

With regard to the beds for cancer which Dr. Buchan regarded as necessary it should be remembered that the districts near London, and to some extent all parts of the country, made use of the hospital accommodation in the Metropolitan area; so far as the information was available about one-half of the patients operated upon in London for cancer of the breast came from outside the Metropolitan area. In the course of an inquiry made by the Ministry of Health as to the total number of patients applying for treatment for cancer of the breast in London, there had been no evidence of any delay in the admission of cases, practically all being admitted within a few days of application.

Of course, we hoped that the number of inoperable cases of cancer would decrease with increased knowledge, though as all inoperable cases had once been early cases, more beds might then be required. But before providing additional beds in a large number of areas it would be well, she thought, to know how far there was actually a need for them.

Dr. M. B. ARNOLD said that in the case of diseases with a distinct seasonal incidence, and with annual cycles, the method of calculating hospital needs on patient hospital days required for the average number notified annually was deceptive, as of course the notifications of, say, diphtheria were not received in approximately equal numbers month by month. In making an estimate some allowance had to be made for the increased needs in the seasons of prevalence. This consideration led to what was the greatest difficulty in isolation hospital work. Most of these hospitals varied between being overcrowded and being half empty. It seemed likely that someone, presumably the medical officer of health, who knew all the hospital provision and all the sickness incidence in a district, might be able to arrange that patients should go wherever there was suitable accommodation available, irrespective of what the beds might have been provided for, and in particular, during the summer, make use of isolation hospital beds not at the time required for their original purpose.

Apart from small-pox, it seemed likely that the custom, peculiar to this country, of treating infectious diseases in hospitals built only for that purpose arose largely through an accident in the history of legislation. It was probably not a result of universal agreement among the epidemiologists and sanitarians. The conception of public health in the minds of legislators in the nineteenth century was that of a struggle against some nine or ten dangerous infectious diseases. The ordinary provision for the sick was already in the hands of others and was not considered part of the functions of the health authorities. Thus, when the latter were given powers to take action with regard to dangerous infectious diseases, such powers included the building of hospitals for those diseases, and fever hospitals were put up with brick walls round them.

Dr. G. CLARK TROTTER (Medical Officer of Health, Islington) said that at one time he had for some years used an infectious diseases hospital for the treatment of other cases. He particularly referred to the treatment of a large number of cases of marasmus, in a special ward, the nurses being drawn from the ordinary staff of the hospital.

It was well known that it was quite possible to treat infectious diseases by the system of "barrier" nursing. It was merely a matter of taking particular care, and several cases of different diseases could be quite well treated in the same ward, or side room. There were certain infectious diseases, however, in which this was not feasible, owing to the intense "infectiousness." He referred especially to chicken-pox, which was apt to spread rapidly unless very extreme precautions were taken; it was quite as infectious as small-pox. Whooping-cough was also another disease which presented difficulties.

On one particular point in Dr. Buchan's paper he did not agree. He did not see why advanced cases of cancer should not receive treatment in the same way that advanced cases of tuberculosis were able to obtain it. It was a blot upon our administration that the poor person suffering from advanced cancer had to remain at home because the relatives objected to the stigma of the Poor Law. This he hoped would be remedied when the proposed arrangements for taking over the public health functions of the Poor Law were completed. The homes in which such advanced cases of cancer had to be treated were often entirely disorganized; the relatives were knocked up with nursing, which they could not carry out efficiently; and from lack of means occurring through loss of work due to the wage earner having to take his or her turn in watching the patient, and then collapsing under the strain, the family got into dire straits.

Treatment could be obtained for some infectious diseases and not for others; there was a difficulty in procuring treatment for those diseases specified as non-infectious. The whole subject was considered from a wrong point of view; it did not matter what "tag label" was attached to the particular case, for the value of the life and the proper nursing and recovery were the same to the community, whatever the disease from which the patient was suffering. As was well known, there were certain seasons when there was not such a call on fever hospital beds, and the beds might well be utilized for non-infectious cases.

Apart from the Poor Law, the patients in chicken-pox cases could not get hospital treatment anywhere in London. The Metropolitan Asylums Board authorities stated that

22 Buchan: *The Hospital in Relation to the Public Health*

they had no mandate to take in chicken-pox cases and declined to receive them. He (Dr. Trotter) was thus in a difficulty when medical practitioners applied for advice as to what could be done for such cases.

Dr. Buchan's paper was of special value in emphasizing that a hospital to which cases could be referred when necessary by the public health department was of definite value to the community, and that it should not matter what the disease was from the public health point of view, as the aim in view was the end-result—facilities for proper recovery.

Dr. T. S. McINTOSH agreed that it was best to have one large hospital for all conditions, including infectious diseases. The long list of diseases which Dr. Buchan gave for which provision had to be made in a municipal hospital seemed to indicate that hospital provision should simply be made for all those who needed it, and not merely for those who suffered from certain special diseases. This opened up the still larger question of public provision of medical treatment generally. Public medical treatment had been provided for one disease after another and for one category of persons after another, as attention for one reason or another had become specially focused on these diseases and categories; but he (the speaker) suggested that we had now reached a point at which that basis should be abandoned and that public medical treatment should be provided for people because they needed it, rather than on the somewhat irrelevant grounds that, for example, they suffered from a particular disease, were of a particular age or attended a particular class of school.

Dr. S. MONCKTON COPEMAN, F.R.S. (President), said he agreed that it was of importance to get rid of the taint of pauperism at present connected with treatment in Poor Law infirmaries, if successful action on the lines indicated by Dr. Buchan was to be attained. As the result of experience gained in connexion with work on behalf of the Departmental Committee on Cancer, set up by the Ministry of Health about three years ago, he was unable to accept the suggestion that the majority of post-operative cases of cancer, or of cases of that disease coming under observation at too late a period for operation to be undertaken, found their way into Poor Law institutions, except, for the most part, in the very latest stages of the disease, when the patient was practically moribund. Before the Great War the case was somewhat different, and patients were usually available in the event of trial of any special methods of treatment thought desirable in their interest. But whether because of the unemployment benefit now rendering it possible for them to remain in their own homes until the final stages of the disease had been reached, or for some other reason unknown, notwithstanding increased incidence of the disease, the number of cancer cases admitted to the various infirmaries had considerably decreased of recent years—moreover, of those admitted many were so seriously ill that it was now somewhat exceptional for them to survive for more than about a couple of months from the date of their admission to the infirmary. It was obviously most undesirable from the public health point of view, that cancer cases, especially when they had advanced to the stage of suppuration, should be treated in dwellings having a minimum of accommodation. If, under a scheme such as Dr. Buchan had outlined, the difficulties and possible dangers incidental to the care of patients under such conditions could be eliminated, a notable advance in hygiene would be attained.

Section of Laryngology.

President—Dr. ANDREW WYLIE.

Cinematograph Demonstration: Effects of Nerve Anastomosis on the Movements of the Vocal Cords and Diaphragm.

By Sir CHARLES BALLANCE, K.C.M.G., C.B., M.V.O., and LIONEL COLLEDGE, F.R.C.S.

THE film shows the movements of the vocal cords of a dog and of a monkey, after anastomosis of the recurrent laryngeal nerve with the phrenic. In the dog, on the right side, the phrenic root from the sixth cervical nerve was divided, and united end-to-end with the recurrent laryngeal nerve, while the distal end of the divided sixth cervical phrenic root was united end-to-end to the descendens noni nerve. On the left side the whole trunk of the phrenic nerve was divided, and then united end-to-end with the recurrent laryngeal. In order to obviate persistent paralysis of the corresponding half of the diaphragm, the descendens noni nerve was divided, and its proximal cut end united to the distal cut end of the phrenic nerve. The movements of the vocal cords may be seen. The right cord moves more vigorously than the left, because the anastomosis on the right side was made several months before that on the left. The diaphragm has entirely recovered from paralysis. Professor Elliot Smith, with his assistants Dr. Beattie and Dr. Melville, has examined this animal and several others, and he reports that the contractions of the diaphragm are entirely normal.

In the monkey, on the right side, an end-to-side anastomosis was made: the cut end of the recurrent laryngeal nerve was sutured to the side of the phrenic nerve. On the left side the phrenic nerve was divided and its proximal cut end united to the distal cut end of the recurrent laryngeal nerve; so that on the left side the whole nervous current of the phrenic is passing into the recurrent laryngeal, while on the right side—that of the end-to-side anastomosis—presumably not the whole nervous current of the phrenic is passing into the recurrent laryngeal. In the monkey the left vocal cord is moving much more than the right. So we may assume that the use of the whole phrenic was not necessary for satisfactory recovery of the movement of the vocal cord.

Another anastomosis was made but is not shown in the film. When the descendens noni has been divided and used for anastomosis with the distal phrenic, there will, unless a further operation is carried out, be permanent paralysis of the depressor muscles of the larynx, the sterno-hyoid, the sterno-thyroid, and the omo-hyoid. It is easy to extend the distal part of the descendens noni after using the proximal part for anastomosis with the phrenic—and to suture it to the side of the hypoglossal nerve. The descendens noni has a tortuous course, and, when dissected out, is found to be much longer than might be imagined. This anastomosis has been carried out on many occasions, and always with success, namely, recovery of the movement and function of the depressor muscles of the hyoid bone and of the larynx.

To sum up: paralysis of the vocal cords may be cured by anastomosis of the recurrent laryngeal nerve with the phrenic; paralysis of the muscle of the diaphragm may be cured by uniting the phrenic to the descendens noni; and paralysis of the depressor muscles of the hyoid bone and larynx may be cured by uniting, end-to-side, the cut end of the descendens noni to the lower side of the hypoglossal nerve.

These three operations may now be added to those which the laryngologist already carries out.

2 Ballance and Colledge: *Nerve Anastomosis*

Discussion.—Mr. E. B. BARNES said he would describe a case in which Sir Charles Ballance had performed one of these operations on the human subject. The patient was a lady, aged 52, whose thyroid had been operated upon in 1925. He (the speaker) had first seen her in May, 1926, when she was suffering from aphonia and severe dyspnœa. Tracheotomy had not been performed. Her vocal cords were completely paralysed, and when she attempted deeper respiration than normal they tended to come together. The thyroid operation had been carried out in London. Having heard Sir Charles Ballance describe these operations at a previous meeting of the Section, he (the speaker) had written to him about this case, and on June 5, 1926, Sir Charles had operated on the patient and made an anastomosis of the recurrent laryngeal nerve with the phrenic on the right side. The left side was similarly treated one month later. The recurrent laryngeal was deeply involved in the scar on both sides; it was united to about one-third of the phrenic. Seven weeks after the first operation there was a definite improvement in the tone of the right cord. Eight weeks later the diaphragm was still paralysed on both sides. The patient now had well-marked movement of the right cord, and the arytenoid on the left could just be seen to move. The diaphragm had recovered on both sides. He (Mr. Barnes) was indebted to Mr. W. F. Wilson, of Newcastle-upon-Tyne, for the report on the present condition.

Sir DAVID FERRIER said he desired to compliment Sir Charles Ballance and Mr. Colledge on this very beautiful demonstration. It had been his (the speaker's) privilege to see many of these operations—the skilful cutting and uniting of the nerves, and it had been very interesting to follow, week by week and month by month, the gradual recovery of the animals so experimented on, particularly in those operations of anastomosis of the phrenic nerve with the recurrent laryngeal. The recovery ensued after a varying time. This ocular demonstration to-day had supplied convincing testimony as to the recovery of function after the operations. Whether the recovery was complete in every detail, or whether in man, after a similar operation, all the finer and more delicate movements of the larynx would be restored, remained to be seen. These experiments were only part of a very extensive investigation which was being carried out by Sir Charles Ballance; only those concerning the vocal cords had been brought forward on the present occasion; but the whole subject was one of great importance.

Sir CHARLES BALLANCE said that the dog selected for these experiments was one which had barked incessantly, the baboon was one which had been always "barking" in the way peculiar to the species. After the operation the dog did not bark for three months. Then he began again, and he was now barking worse than ever, so that he was a nuisance. He (Sir Charles) was not quite sure whether the *timbre* of the voice was now the same as before the operation. The result of the operation on the baboon was very much the same.

He (the speaker) would not say that, in man, after these operations every function of the cords would probably be restored, but he thought that, in the future, there would be no excuse for laryngologists leaving paralysed vocal cords untreated.

Perforation of the Palate.

(Shown at December and June Meetings.)[1]

By H. BELL TAWSE, F.R.C.S.

MRS. J., aged 44.

It was recorded in June that there was a small, smooth swelling on the upper surface of the left palate and that the left palate was much thicker than the right, which was perforated. This condition remained stationary until the end of August when a change was noted. At this time what looked like a small mass of granulation tissue appeared on each side of the posterior border of the septum, more marked on the right.

The pathological report on these masses, from two laboratories, is the following: (1) Sections show masses of squamous-celled carcinoma surrounded by much inflammatory tissue.

[1] See *Proceedings*, 1925-26, xix (Sect. Laryng.), pp. 23, 61.

(2) The section shows a malignant growth—a squamous-celled carcinoma. There can be little doubt that it has originated as a carcinoma of the more simple epithelium seen in this region, and has become squamous by metaplasia. It may have been more difficult to diagnose in an earlier condition.

Now (November 5) the tumour is growing rapidly, the upper surface of the palate is ulcerating and neuralgic pain on the left side of the head is complained of.

Remarks.—It must be presumed, I think, that the cause of the perforation of the palate was an epitheliomatous ulcer on the upper surface of the right palate, and that the epitheliomatous cells died probably from lack of nutrition (otherwise why should the perforation lessen, and the edges heal firmly?).

(*Microscopic slides shown.*)

Discussion.—Dr. W. H. KELSON said that when he had first seen this case, in June, 1926, he had remarked that there was little to indicate the cause of the trouble, but that it might prove to be one of cancer. He (Dr. Kelson) had shown two cases before the Section in which there had been a mysterious ulceration, which did not correspond to that found in tuberculosis or syphilis or malignant disease, but which later became definitely malignant. The present case confirmed the impression that many cases of indefinite nature really were, or ultimately became, malignant.

Sir WILLIAM MILLIGAN said that there was a growth on the left side of the vault of this patient's naso-pharynx. Did Mr. Bell Tawse consider that there was a contact infection? Apparently the growth which had caused the perforation of the palate had begun on its posterior aspect, and there was a fair amount of infiltration of tissue. Contact cancer *did* occur, though rarely. What treatment was proposed in this case? The patient was now beginning to suffer severely from neuralgia, and an attempt should be made to relieve that. Was it worth while to try diathermy? This was likely to afford considerable relief, even if it did not entirely destroy the growth.

Mr. BELL TAWSE (in reply) said that the growth on the naso-pharynx had appeared a month after the septal condition was noted. He (the speaker) did not see why it should be considered a contact cancer, as the left half of the soft palate did not show any ulceration. There was no doubt that the perforation was due to an epitheliomatous ulcer of the right half of the palate. He (Mr. Bell Tawse) had brought the patient chiefly for advice as to treatment. He was disposed to try treatment by intensive X-rays first, but was not inclined to use diathermy, as its proper application would necessitate a very extensive preliminary operation. He considered the case inoperable and later on he would employ radium. He regarded the persistent neuralgia as a symptom of grave significance.

Acute Frontal Sinus Suppuration: an Unusual Variation in the Anatomy.

By H. BELL TAWSE, F.R.C.S.

D. M. B., AGED 21.

June 20.—Severe cold in nose was rapidly followed by acute pain in forehead and a high temperature. This continued for nearly three weeks, when the pain subsided, as a swelling appeared in the middle line just above the root of the nose.

July 10.—First seen by exhibitor. The swelling was obviously an abscess and the skin over it was red, and rupture was imminent. Some pus was seen in the right middle meatus and the anterior end of the middle turbinal was swollen and red. As the left nose seemed normal it was decided to open the right frontal sinus at once, so as to try to obviate a scar on the middle of the forehead, which would result if the abscess burst. Therefore no X-ray photograph was taken. The usual curved incision exposed a tiny fistula on the anterior wall of the right frontal sinus—the sinus was very small and was full of pus.

4 Tawse: *Frontal Sinus Suppuration;* Kisch: *Frontal Sinus Operation*

Inter-sinus septum intact. Anterior end of middle turbinal removed. Tube passed from sinus into nose and fixed.

July 29. *X-ray Photograph. Report.*—Left frontal sinus shows increased density. There is a shadow in the middle line suggesting a sequestrum in the frontal sinus. Drainage tube seen.

August 4.—Considerable pain over the left frontal region, and the X-ray report decided me to open the left frontal sinus, by the usual incision. Fistula found. Sinus large and full of pus. Probe passed into ostium frontale took a strange course and could not be seen in the left nasal cavity. Found in the right nose.

Right frontal sinus wound opened up. Probe from left side seen passing beneath a slit at the lower border of the inter-sinus septum, which reached to the lowest part of the cavity and was otherwise intact.

The inter-sinus septum was removed and the cavity drained as before.

Remarks.—(1) Can one reasonably assume that the inter-sinus partition was a mere buttress and not a true septum, and that there is total absence of a left frontal sinus?

(2) Had the X-ray report been available before the first operation, the left sinus would have been opened and I should certainly have failed to realize that I had opened a large recess of the right one.

(3) The combination of a persistent frontal suture and absence of one frontal sinus is not common.

(4) The second operation on the right side has rather interfered with the cosmetic result.

(*X-ray plates shown.*)

Discussion.—Mr. C. A. S. RIDOUT said that some years ago he had found in a soldier-patient an abnormal anatomical condition—that of a double frontal sinus. He (the speaker) had been curetting, when suddenly the curette had given way, and another cavity was revealed, which turned out to be the right frontal sinus overlapping the left. Possibly such a condition might have been present in Mr. Bell Tawse's case.

Mr. W. STUART-LOW said that in a number of somewhat similar cases he had found that the neuralgic pain frequently experienced in these conditions of acute and subacute sinusitis was much relieved by the application of actinic rays from a carbon-arc lamp applied for half an hour at a time. These rays had great penetrative power; they relieved the congestion, and allayed the deep throbbing pain so depressing to the patient.

A New Frontal Sinus Operation.

By H. A. KISCH, F.R.C.S.

A YOUNG woman, aged 27, complained of persistent headaches, so severe sometimes that she could not see across the street. She had been treated, without success, for migraine and dyspepsia; the ophthalmic surgeon reported vision normal, $\frac{6}{6}$ both eyes. Her tonsils had previously been removed and a nasal septum deflection corrected. The patient complained of discharge from the nose and of an unpleasant smell. Further examination revealed that a multiple sinusitis was the condition present. An external frontal sinus operation was first performed on the left side. The technique of the operation is as follows:—

The skin incision is made from just internal to the supra-orbital notch, downwards, internal to the internal canthus of the eye, for about an inch. It is then deepened to the bone, and hæmorrhage controlled. The periosteum is incised, and the ascending process of the superior maxilla exposed. The orbital contents are *not* retracted. With a chisel an oblong portion of the ascending process of the superior maxilla is

removed ; the opening of the fronto-nasal duct is thus immediately exposed, and pus is often seen exuding from it. More bone is then removed, until the orifice of the frontal sinus is thoroughly exposed ; the frontal spine is removed. The state of the sinus is examined with a probe, and any polypi present are removed. The ethmoidal region, which is easily visible by this route, is then exenterated. The middle turbinal is usually left, or, at any rate, not removed until the end of the operation. The wound is closed carefully with clips. No tube is used, or is necessary.

In this case, the symptoms did not clear up until the operation was also performed on the right side. The deformity from the operation is negligible.

Discussion.—Mr. W. STUART-LOW said that Mr. Kisch's new operation was a very good one, especially for acute and subacute cases where fluids only had to be evacuated and drainage established, since little or no scarring or puckered depression resulted. Where polypi were present or where polypoid degeneration of the mucous lining of the sinus had resulted, this operation would most likely be on too limited a scale to allow of the ultimate ramifications of the large sinus being cleared.

Mr. KISCH (in reply) said that the operation was designed for suppurative disease of the frontal sinus without very extensive polypoid formation. Directly the opening was made, one could feel, with a probe, whether there was extensive polypoid involvement, in which case the incision must be extended, the eyeball retracted, and the floor of the frontal sinus removed and dealt with in the ordinary way.

Total Removal of Tongue by Diathermy for Carcinoma.

By C. A. S. RIDOUT, M.S.

J. W., MALE, aged 63. First seen January, 1924, with pulsating ulceration and induration of left half of the tongue, extending from the base to within 1 in. of the tip, with much fixation to the floor of the mouth. Operation, January 10, 1924. The left submaxillary triangle was cleared of all glandular structures, and the left lingual artery ligated ; the left half of the tongue removed at the same operation and diathermy applied to the stump. As some indurated nodules remained after recovery, the whole of the tongue subsequently was destroyed by diathermy. Recovery of speech remarkable ; resulting scar noticeably soft. No infiltration of glands.

Epithelioma of Left Tonsil, Left Anterior Pillar of Fauces, Tongue and Lower Jaw.

By C. A. S. RIDOUT, M.S.

W. S., MALE, aged 65. First seen May 9, 1923, with ragged ulcer situated in region of left anterior faucial pillar involving left tonsil, left side of tongue, and extending to left horizontal ramus of lower jaw, size of a half-crown. Extensive dental sepsis. Teeth removed May 14, 1923. Operation May 18, 1923. Enucleation of left tonsil partly by dissection ; remainder of ulcer destroyed by diathermy. Previously the left external carotid artery was ligatured ; the neighbouring lymphatic glands were removed. March 26, 1924 : Sequestrum removed from lower jaw. Pathological report : Epithelioma. No involvement of glands.

Epithelioma of the Tonsil in a Woman.

By NORMAN PATTERSON, F.R.C.S.

PATIENT, aged 62, female, married.

History.—Three years ago noticed two small lumps on the right side of the neck. A year and a half ago pain was complained of in the region of the swelling, and also in the throat. At this time she was seen by Mr. Russell Howard, who diagnosed malignant glands of the neck and sent her to the exhibitor to see if he could find

6 Patterson: *Epithelioma of the Tonsil in a Woman*

a primary focus. No such focus was discovered. About a year ago, however, there was a small, irregular area on the right tonsil. A portion of this was removed for microscopic examination, and it was found to be epithelioma. Examination shows a very large firm mass in the neck, and there is a definite carcinoma of the tonsil, which, however, is still of moderate dimensions.

This case is shown on account of the rarity of epithelioma of the tonsil in women, and because at his first examination, even when the glands were already much enlarged, there was no evidence of a primary focus. The disease may have started in one of the crypts.

Discussion.—Sir STCLAIR THOMSON said these cases were particularly interesting if some principles could be deduced from them, and not mere bare records. Mr. Patterson had pointed out two. First, the rarity of malignant disease of the tonsil in women. In his (the speaker's) book there was a diagram based on the work of Dr. Logan Turner, at whose clinic, as against sixty-five male patients suffering from malignant disease of the fauces, soft palate and tonsils, there were only five female patients. The figures of sex incidence were very different for the post-cricoid region. The other point was the long period which elapsed between the appearance of the glands in the neck and the discovery of a primary focus, namely, two years. He (the speaker) had that day seen two cases illustrating this point. One was that of a patient from whose neck a malignant gland had been removed a year previously. A month ago a swelling had developed in a gland on the opposite side, with some Eustachian obstruction. And now an early malignant growth had been discovered in the roof of the naso-pharynx on the right side. That case showed that there might be a latent period of a year, and that the primary focus might be on the side opposite from that in which the first glandular enlargement appeared. The other case had been under the care of Mr. Carson. A gland had been removed from the neck in June, 1924, and the patient had remained absolutely well for a year, after which there had been some recurrence of symptoms. The case had been sent to him (Sir StClair) two years ago, and he could then find no primary focus. The patient was inspected at intervals, yet it was only last month, i.e., twenty-seven months since the first glandular swelling had appeared, that a primary growth was discovered on the side of the pharynx.

Dr. DAN MCKENZIE said that these cases were of the utmost practical importance. The fact that a malignant gland might appear without an obvious primary focus was well known in general surgery. When a careful examination in a case of malignant cervical glands failed to reveal the primary focus, clearly the tonsils should be removed and examined microscopically. The operation was only slight, even if nothing was found, but if a small growth was present in one of the crypts, the prospects of treatment would be greatly enhanced by the removal of the tonsil.

Mr. W. M. MOLLISON said he was able to quote a case resembling those mentioned by Sir StClair Thomson. The patient, who had been under the care of Sir Alfred Fripp, had had swollen glands in the right side of the neck. On examination of a section, the glands were found to be carcinomatous. No operation was performed, the patient instead being sent to the Radium Institute. After treatment there, the swelling in the glands had disappeared, he (the speaker) had examined the patient, but had failed to find the primary focus. She returned two years later and he had then found a small growth in the opposite side of the naso-pharynx.

Mr. L. G. BROWN asked whether, in Mr. Patterson's case, a microscopical examination had been made of both the tonsillar growth and the malignant gland in the neck. Possibly the glandular enlargement was of a primary malignant nature, and the tonsillar growth was concurrent. This suggestion somewhat upset the canons of opinion as to the occurrence of malignant disease in several sites of the body at the same time, but since malignant disease followed chronic conditions, he suggested that a chronic diseased condition of the tonsil would cause chronic adenitis, and that malignant disease might supervene on both sites primarily and independently of one another, but in this instance having this much in common, that the precursor of the malignant disease—that is, the chronic inflammatory condition—was the result of a similar form of irritation.

Mr. RIDOUT (in reply) said that his patient had an extraordinarily good voice, and after the diathermy the scar was quite soft and supple.

Mr. PATTERSON (in reply) said that Mr. Ridout was to be congratulated on the results of his cases. With regard to Mr. Brown's remarks: there was no justification for removing a portion of the gland for microscopical examination. Mr. Brown's remarks were interesting, but he scarcely thought that they applied to his (the speaker's) patient. The primary tumour was found to be carcinoma and no doubt the secondary mass in the neck was of the same nature. He (Mr. Patterson) agreed with Dr. Dan McKenzie that it might be advisable, in some cases, to remove apparently normal tonsils and subject them to close pathological investigation.

Arrest of Widespread Post-operative Osteomyelitis of Face and Cranial Vault.

By DAN MCKENZIE, M.D.

THE patient, a male aged 21, was referred to us after the disease had made its appearance. It had followed a simple curetting of the right ethmoid. There have been several operative removals of bone, comprising part of the frontal, evacuating subpericranial and extradural abscesses; both nasal bones; most of the ethmoids, including the (?) crista galli (on exhibition); the bony nasal septum; and, lastly, part of the outer wall of the right orbit. The right superior maxilla was becoming extensively involved when the disease was brought to a standstill. The credit for an unexpectedly favourable result is assigned to intravenous colloid silver ("electrargol") in doses of 10 c.c. daily. This is the third case I have shown in which intravenous colloid silver seems to have arrested post-operative osteomyelitis.

Discussion.—Mr. H. TILLEY said Dr. McKenzie was to be congratulated on this case. The result almost persuaded him to be an optimist with regard to this complication of frontal sinus suppuration. He asked what organism had been found. He (the speaker) had not found that electrargol cured acute streptococcal blood infections, while it was sometimes very useful as a remedy against the effects of the staphylococcal group of organisms.

Dr. DAN MCKENZIE (in reply) said that the organism responsible for spreading osteomyelitis seemed to be unknown. He thought that the clinical behaviour of this type of osteomyelitis suggested a staphylococcal, rather than a streptococcal infection.

Case of Subglottic Stricture of Trachea.

By HERBERT TILLEY, F.R.C.S.

G. J., MALE, aged 20. Tracheotomy at age of 14 months. Tube removed six months later, but subsequently difficulty in breathing set in, which slowly increased with succeeding years so that hurried walking or exertion produced distress. Laryngoscopic examination showed a subglottic stricture of trachea about the level of the second or third tracheal ring; this was confirmed by direct laryngoscopy.

February 26, 1925: Low tracheotomy performed under general anæsthesia. The membranous constriction was dilated with curved, graduated, steel urethral bougies, which were passed upwards into the larynx. A sheaf of drainage tubes about 4 in. long was then passed from below upwards, and retained in the stricture for four days. Since then the breathing has remained as free as it is at present, and the patient suffers from none of the discomfort above referred to. The patient can now breathe without the tracheotomy tube, and the voice is good.

8 Ibbotson—Watson-Williams—Jewell

Neuro-fibro-sarcoma.

By WILLIAM IBBOTSON, F.R.C.S.Ed.

D. B., AGED 36. Female. Married. *History.*—Hit over left side of face by an overhead tram-wire, July, 1923. Swelling of left cheek since June, 1924, no pain or tenderness. No nasal discharge. Frontal and nasal pain when tired. *Examination.*—Hard mass on left cheek, fixed, not tender, no fluctuation. Left ethmoidal and inner portion of left maxillary sinus dark to transillumination. *Treatment.*—September 24, 1924. Operation: Excision of tumour by shelling it out of the soft parts of the left cheek, the bone not being involved. The left infra-orbital nerve passed through the middle of the neoplasm, and was therefore removed also. *Microscopical Diagnosis.*—Neuro-fibro-sarcoma. *Clinical Diagnosis.*—Traumatic in origin. Has been treated by radium since, and, so far, there has been no recurrence.

Monocle Mirror.

By E. WATSON-WILLIAMS, F.R.C.S.

THIS is a 2 in. mirror, very light, mounted on a hinge to a monocle-frame. A fixed form is also shown, with the outward deflection unchangeable; a third form can be clipped to the outer margin of a spectacle glass, and hinged there. The ring on which the monocle form is mounted must, of course, fit the wearer, and thus it cannot be ordered without reference to the size suitable—this is necessarily the case with any monocle. This mirror gives as much light at the bottom of a deep, narrow cavity as the larger forehead mirrors, rays from the margin of which do not reach the bottom of such a cavity.

Dr. JOBSON HORNE said he had some recollection of a reflecting mirror being used as a monocle. The idea was illuminating and amusing, but not sufficiently illuminating to be of practical application in the examination and treatment of the nose and throat.

? Adenoma of the Parotid.

By W. H. JEWELL, M.D.

E. B., AGED 57 years. Thirteen months' history. Painless, firm and almost immovable tumour. Situated in front, below and behind the lobule of the right ear.

Mr. JEWELL said he believed the growth was a parotid tumour, but he was not sure that it was malignant. It might be an adenochondroma, but he had not seen one so hard and fixed. He was inclined to attempt to remove it. Treatment with radium had been suggested.

Postscript, November 16.—Tumour removed. Pathologist's report: Mixed parotid tumour.

Section of Odontology.

President—Mr. J. B. Parfitt, L.R.C.P.Lond., M.R.C.S., L.D.S.Eng.

The Lymph Supply of the Dentine and Enamel.

By E. W. Fish, M.D., Ch.B., L.D.S.

(*From the Department of Biochemistry and Physiology, University College, London.*)

In a paper read before this Section at the end of last session,[1] a series of experiments was described which had been arranged to demonstrate the movements of lymph in the dentinal tubules. It was found that particles of indian-ink pigment were carried from the pulp along a lymph space between Tomes's process and the wall of the tubule, and that these particles had been traced as far as the middle third of the dentine, a position to which they had been carried within an hour of their introduction into the tissues of the pulp.

By using a solution of ferrous ammonium citrate it was found possible to demonstrate complete irrigation of the dentine by lymph, but this indicator is not

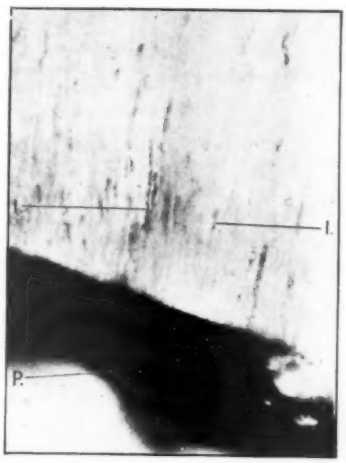


Fig. 1.—Photomicrograph of tooth of dog. Indian ink was introduced into the pulp, P., of this tooth one hour before the dog was killed. No pressure was used. The particles of pigment, I., are seen to have entered the lymph space of the tubules and have been carried up the tubules for some distance. (1/6 in. objective.)

very convenient for critical investigation of the distribution of the lymph, since it diffuses very readily into the matrix of the dentine.

It has, however, been found that solid methylene blue is admirably suited to this type of investigation, since after its introduction into the pulp during life it becomes dissolved in the lymph of the pulp and distributed to the dentine and enamel. In the dentine it is confined to the tubules and their branches, from which it passes to the enamel and irrigates the prism sheaths.

Technique.—A fully adult dog is anæsthetized with chloroform and ether after the administration of a hypodermic injection of morphia. A cavity is drilled in the crown of one of the teeth near the neck and the pulp is freely exposed. A small quantity of solid

[1] E. W. Fish, "Circulation of Lymph in the Dentinal Tubules with some Observations on the Metabolism of the Dentine," *Proc. Roy. Soc. Med.*, 1926, xix (Sect. Odont.), pp. 59-72.

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methylene blue is introduced into the cavity and gently worked into the pulp with a probe, without destroying the tissues of the pulp. A trace of moisture is then added to the dye to ensure its solution in the lymph of the pulp, and the cavity is covered with a smear of temporary cement. It is not sufficient merely to place the dye on the exposed pulp, since it will be walled off from the pulp tissues by inflammatory reaction and will not enter the circulation in sufficient concentration. The dog is kept under morphia and killed from twelve to twenty-four hours later.

The result of this experiment is a profound change in the appearance of the teeth which have been operated upon. A wide zone of a dense blue colour develops round the part of the tooth at which the dye was introduced, and where it has entered the enamel the enamel has the appearance of dark blue Bristol glass. The teeth may be preserved in 10 per cent. formaline solution indefinitely and sections are prepared by grinding. After they are ground the sections are immersed in 6 per cent. ammonium molybdate solution for twenty-four hours, then freshened up on the hone and mounted in Farrant's medium.

(I) *The Intrinsic Circulation of Lymph in the Tooth.*

In the earlier report of this investigation, to which reference has already been made, evidence was given which would appear conclusive of the flow of lymph up the

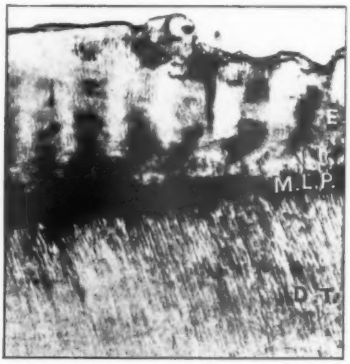


FIG. 2.—Photomicrograph of tooth of dog. Methylene blue was introduced into the pulp of this tooth through a cavity drilled in the crown twelve hours before the dog was killed. The dye, becoming dissolved in the lymph, is seen to have been carried up the tubules of the dentine, D.T., to the marginal lymph plexus, M.L.P., formed by the anastomosis of their terminal branches. From the lymph plexus the dye has been carried on into the enamel, E. (2/3 in. objective. Red colour filter.)

dentinal tubules, and as the tubules were seen to end by bifurcating and dividing into branches which contained lymph, it was assumed upon certain experimental evidence that the branches must anastomose and form a marginal lymph plexus along which the lymph might pass to other parts of the dentine, and so back to the pulp at a place where the lymph pressure was not so high. It is not suggested that a given molecule of lymph necessarily traverses the complete path, but that the movement may be in the nature of an ebb and flow along this path. The present series of experiments permits of this phenomenon being actually observed.

The dyed lymph may be traced along the tubules which occasionally bifurcate as they go out to the margin of the dentine. When the tubules reach an area just short of the enamel or cement junction they divide up into their terminal branches. These branches all lie in longitudinal planes parallel with the long axis of the tooth —an observation which may be verified by examining a series of longitudinal

sections of those teeth which show the branches, while transverse sections of the teeth do not show the branches except in cross section, cut across immediately the tubule bifurcates.

These terminal branches of the tubules may be seen to anastomose freely and form the *marginal lymph plexus*. The importance of the plane in which the branches of the tubules lie now becomes apparent, since their longitudinal arrangement permits the lymph to travel up or down the tooth so that it may return to the pulp along the tubules at some other level where the lymph pressure is not so great.

Presumably, it would be impossible for a flow of lymph to take place round the tooth in the same transverse plane since there would not be any difference of pressure in the tubules in that plane. Hence, there are no anastomosing branches to permit of a flow in this direction.

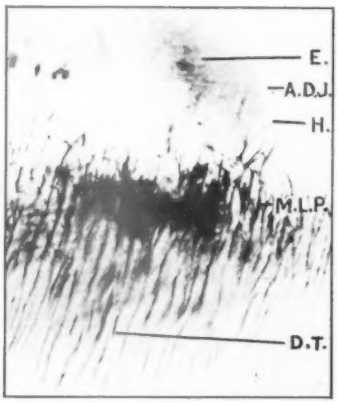


FIG. 3.

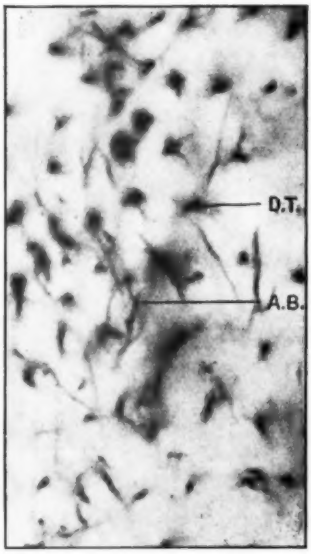


FIG. 4.

FIG. 3.—Higher magnification of fig. 2, showing the terminal branches of the tubules anastomosing to form the marginal lymph plexus, **M.L.P.** **D.T.**, dentinal tubules carrying the dyed lymph. **H.**, homogeneous layer of dentine between the plexus and the enamel, **E.** **A.D.J.**, amelo-dentinal junction. (1/6 in. objective. Red colour filter.)

FIG. 4.—Section through the marginal lymph plexus showing the dentinal tubules, **D.T.**, in cross section and their branches, **A.B.**, anastomosing with each other. (1/6 in. objective. Red colour filter.)

Examination of longitudinal sections of these teeth shows the dyed lymph in the marginal lymph plexus which is formed by the anastomosing end-branches of the tubules, and also in places it is seen that the lymph has travelled along the plexus towards the crown or the apex, as the case may be, to a part where the tubules are still free from dyed lymph. It is therefore impossible for the dye to have passed up the tubules of this part of the dentine, and we are able to conclude that there is, in fact, a movement of lymph along the plexus itself towards some other part of the dentine.

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We may now consider the further movements of the lymph from the lymph plexus outwards towards the enamel and the cement.

In the crown of the tooth under the enamel it is found that all the lymph does not pass along the lymph plexus and return to the pulp immediately, since it may proceed to the enamel, where it irrigates the organic tissue of the prism sheaths.

The course pursued by the lymph would appear to be this: Tubules carrying the dyed lymph are seen to leave the lymph plexus and proceed across the narrow intervening zone of dentine towards the enamel. This zone is more homogeneous than the rest of the dentine, in that fewer tubules appear to traverse it, and the

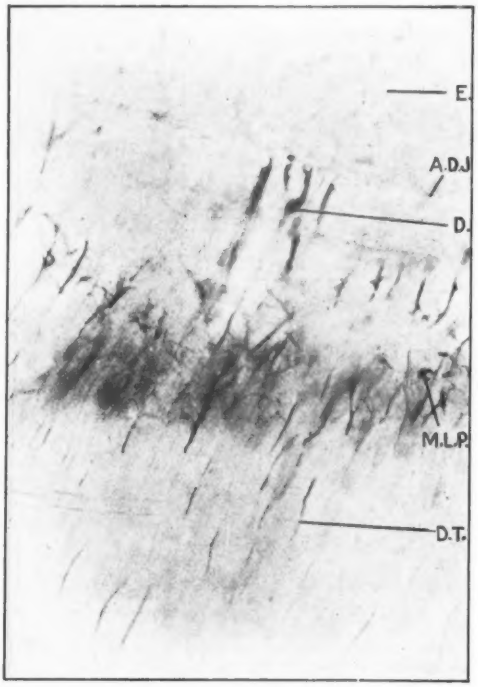


FIG. 5.—Similar to fig. 3, but showing tubules, D., leaving the marginal lymph plexus, M.L.P., and carrying dyed lymph to the bases of the enamel prisms, E., at the amelo-dentinal junction, A.D.J. D.T., dentinal tubules. The tubules, D., are seen to dilate and give off small branches which proceed to the prism sheaths (see fig. 6). (1/6 objective. Red colour filter.)

tubules which do so may prove to be either ordinary dentinal tubules which have passed through the marginal lymph plexus without breaking up into branches, or they may be new tubules formed by the anastomosis of branches from the plexus. Certainly some would appear to be formed in this way, and it is interesting to speculate whether they contain a Tomes' process, or are mere lymph channels. In any case they are seen to contain the dyed lymph and to proceed to the enamel margin.

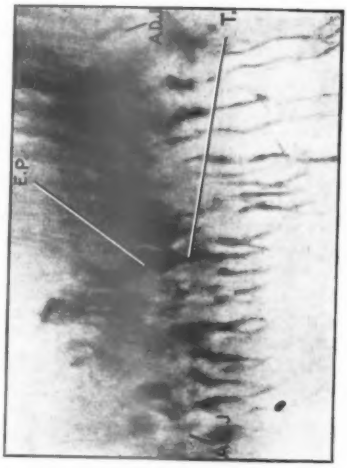


FIG. 6 B

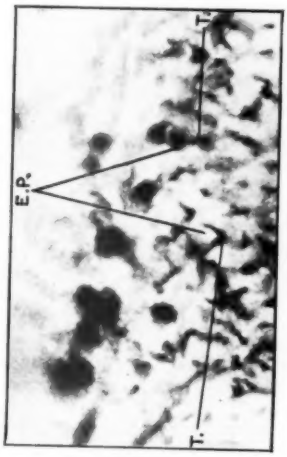


FIG. 6 D

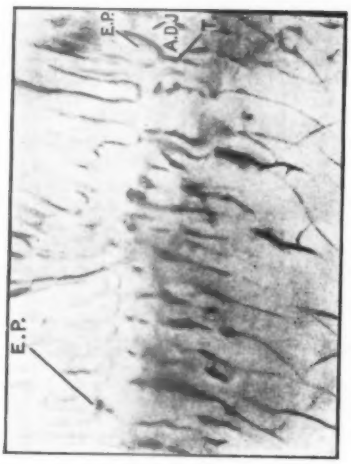


FIG. 6 A



FIG. 6 C

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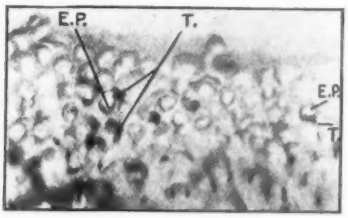


FIG. 6 E

FIGS. 6 A, B, C, D, E.—Photomicrographs of the amelo-dentinal junction of tooth of dog after introduction of methylene blue into pulp during life. The photographs show the ultimate branches of the tubules as they arrive at the bases of the enamel prisms. A and B show the dilatations on these tubules and the dye entering the bases of the prisms. C, D, and E show the prisms and tubules in almost transverse section and the fine terminations of the tubules in contact with the prism sheath. (1/6 in. objective. Red colour filter.)

As these tubules approach the bases of the prisms they form dilatations, from which several minute branches are given off, each carrying the lymph to the base of an individual prism. As this fine branch reaches the base of the prism it may end in a point, but sometimes it appears to dilate once more and to be applied to the

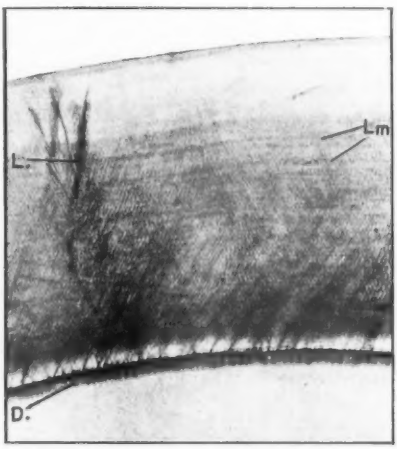


FIG. 7.—Photomicrograph of enamel of tooth of dog, into the pulp of which methylene blue had been introduced. Apart from the sharp line at the amelo-dentinal junction and that at the surface of the enamel, the shading accurately indicates the distribution of the dyed lymph. At D. the dilatations on the tubules, as they reach the amelo-dentinal junction, are seen. In the enamel the prism sheaths are carrying the lymph and are sharply outlined. The traces of grey just below the surface of the enamel indicates that the blue lymph has reached this situation. The laminations, L.M., of the enamel are more heavily coloured than the rest of the enamel, and the enamel lamella (of Gottlieb) L is very richly supplied with lymph owing to its high content of organic material. As this is a transverse section of the tooth the marginal lymph plexus does not show. (2/3 in. objective. Red colour filter.)

prism base very much like the stem of a tobacco pipe merges into the bowl (figs. 6 A, B, C, D, and E).

The lymph, on reaching the base of the prism, passes along its sheath and can be followed by virtue of its blue colour to within a few microns of the surface; at this

point the prism sheath closes over the top of the prism and the ultimate surface of the enamel appears homogeneous and devoid of lymph.

The enamel is, however, abundantly supplied with enamel lamellæ or tufts of organic material which are plentifully irrigated with lymph. Some of these appear to take the dye to the very surface of the enamel and may conceivably form a point at which exchange of material can take place between the lymph and the saliva. It would, however, be difficult to satisfy oneself that there has been no breakage of the actual surface in preparing the specimen.



FIG. 8.—Photomicrograph of transverse section of enamel prisms after introduction of methylene blue into the pulp of dog's tooth during life. The dyed lymph is confined to the enamel prism sheath. The prism itself and the inter-prismatic substance are free from any trace of the dye. (1/6 in. objective. Red colour filter.)

Throughout this description of the irrigation of the enamel with body fluids it has been assumed that the lymph is confined to the prism sheath. This was demonstrated in a paper read before the Sixth International Dental Congress by the present author, and a photomicrograph is reproduced (fig. 8) showing the prisms in transverse section, from which it will be seen that while the prism sheath is deeply impregnated with the dyed lymph the prism itself and the inter-prismatic substance are entirely free.

(II) *The Association of the Lymph Supply of the Tooth with that of the Surrounding Alveolus.*

A description has just been given of the way in which, in the crown of the tooth, tubules leave the marginal lymph plexus and proceed to the enamel. In the root a very similar arrangement is seen to occur. Tubules leave the plexus and cross the granular layer of Tomes to open at the cement junction. It was therefore decided to investigate the function of these tubules and they were found to form a path for the exchange of the lymph from the alveolus across the cement with that of the marginal lymph plexus.

Experiment.—A dog is anæsthetized with chloroform and ether and a minim or two of ferrous ammonium citrate solution is injected hypodermically into the gum margin. Ten minutes later the gum, jaw and teeth are excised and the dog is destroyed. Sections are prepared of the tooth *in situ* by decalcification and are treated with potassium ferrocyanide and hydrochloric acid in order to turn the iron solution blue.

Upon examination the iron-stained lymph is seen to have crossed the cement and to be proceeding down the tubules towards the pulp which it has just reached at one point (fig. 9). Most of the dentine is, however, free from iron solution, and the

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distribution of the stained lymph in the dentine renders it clear that the iron solution has entered the dentine from the periphery and not from the pulp.

It is evident that this is a true lymph circulation and not a mere diffusion, because on transverse section of the tubules carrying the iron-stained lymph, the same peripheral arrangement of the blue lymph is seen as was observed in the case



FIG. 9.—Photomicrograph of tooth of dog *in situ*. Iron solution had been injected into the gum margin ten minutes before killing the dog and fixing the tissues. The iron-stained lymph, I.S.L., is seen to have been carried across the cement and to be proceeding towards the pulp which it has just reached at P. (Planar lens. Red colour filter.)

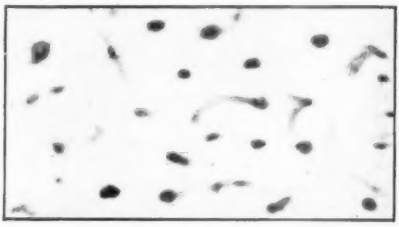


FIG. 10.—Transverse section of tubules from tooth treated as in fig. 9, to show that the stained lymph is confined to the peripheral lymph space of the tubules, which therefore show as rings in transverse section. (1/6 in. objective. Red colour filter.)

of the particles of pigment when indian ink was placed in the pulp and entered the lymph space of the tubules.

This observation corroborates the view that the lymph may flow in either direction along the lymph space of the tubules, that is, either away from or towards the pulp, according to the pressure equilibrium in the tubules.

In conclusion, the author wishes to express his gratitude to the Dental Board for their generous assistance in bearing the expense of this investigation.

Discussion.—Mr. A. LIVINGSTON said he did not think there was any question that lymph circulated in the pulp, in the dentine, and possibly in the enamel. Probably Dr. Fish himself would admit that this had not been absolutely proved, but, from the evidence, it seemed to be possible. An equally important point for investigation would be as to whether there was any exchange between the saliva and lymph in a direction the reverse of that in which Dr. Fish proved that transudation took place. The experiments on the calcium content of the tooth did not, as yet, convey very much information.

Dr. Fish's analyses were worked out very minutely; to weigh to fractions such as one-tenth of a milligram was a feat, and it was to be hoped the work would be continued.

Mr. J. G. TURNER said that Dr. Fish used the terms "osmosis," and "lymph stream," remarking that the lymph stream "carried" either the particles or the colouring matter. But the lymph stream seemed to work in opposite directions, and there seemed to be no particular reason why it should work from the periodontal membrane inwards at the same time that it was working from the pulp outwards. A useful suggestion seemed to be that diffusion alone was at work, for diffusion would be capable of carrying such minute particles as those of indian ink, and the colouring matter of iron, which might itself be minutely particulate. Was there any physical basis for rejecting the diffusion idea?

With regard to the experiments on dogs, he (Mr. Turner) wondered whether some means could not be invented of trying them on the human subject. It seemed that the difference between what was observed in the human dentine and enamel and that observed in dogs was too great to justify the application of what was found in the dog to that found in man. With the microscope in both enamel and dentine of the dog finer structures were seen than in the enamel and dentine of man. Clinically, it was known that human dentine sometimes repaired itself, and that dentine was killed from the inside outwards. Therefore it was clear that there was a circulation. Human cementum was killed from the inside outwards, and there was a passage through from dentine to cementum. Yet in the human enamel he had not been able to trace any connexion clinically.

A second point in regard to animal dentine which might be of help in elucidation of the question was the fact that the so-called secondary dentine was often impermeable to anything. It was known that pulp could be killed by putting arsenic on the sound dentine, so there must be some connexion from without inwards to kill that pulp. But one could never kill pulp by putting arsenic on secondary dentine. A point for comparison might be found here. From the outside one could obtain evidence of micro-organisms passing in through the cementum along what looked like minute lymph spaces, and from the outside one expected there to be the same lymph circulation inwards in human teeth.

Mr. A. BULLEID said that in reference to one of the slides shown, Dr. Fish stated that the stained lymph was in the enamel sheath. He (the speaker) was not very clear what was meant by that.

With regard to the calcium content experiments, apparently the calcium content diminished in quantity as people got older, and he asked whether there was any connexion between that and the possession of a rheumatic tendency. When people had a rheumatic tendency or suffered from arterio-sclerosis was there likely to be a withdrawal of calcium from the dentine?

Mr. F. N. DOUBLEDAY said that he would be glad if Dr. Fish would enlighten the Section as to his mental picture of the circulation of the lymph through the dentine. Dr. Fish said it was due to changes of pressure within the pulp, but he (Mr. Doubleday) did not visualize how one came to see differences in pressure at different levels within the pulp. In the paper Dr. Fish read last session he had spoken of circulation through the dentinal tubes as being influenced by the cells, and that seemed probable.

Did not Dr. Fish think that the odontoblast cells might have some share in that? He (Mr. Doubleday) had been of opinion that odontoblasts could, with their processes, only remain in the dentine so as to provide for its nutrition, and if that was so, the odontoblast cell and its process probably took an active part in the circulation, but not by passing lymph up the cell, because Dr. Fish showed that it passed in the spaces outside the process.

With regard to the influence of partial parathyroidectomy on the calcium metabolism. He had found that in certain cases of pyorrhœa he could produce satisfactory results by the

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administration of parathyroid tablets, combined with calcium salts. Though the experiments Dr. Fish had done in this matter were as yet small, they bore out what Mr. Broderick taught, and what clinical experiment had shown to be true.

Mr. BAYFORD UNDERWOOD said he did not think there need be doubt any longer as to lymph circulation in the dentine. With regard to the enamel, however, he took it that Dr. Fish himself was not convinced that the lymph stream travelled the whole way through to the surface. Had Dr. Fish any idea as to what happened if it did not get through to the surface? If the lymph stream did not pass through the enamel, it must pass out somewhere. As to the cementum, Dr. Fish would of course make further investigations, but he did not fully explain how the lymph travelled through the cementum. Could he make any further statement about that? With respect to Mr. Doubleday's remark about the odontoblast, it seemed likely that soon no function would be ascribed to it. Its function of sensation had been removed, and now its function of nutrition was threatened. Then it would be difficult to justify the existence of the odontoblast at all.

Mr. J. B. PARFITT (President) said it was of interest to him to see that the teeth in pyorrhœa showed a diminished calcium content; did Dr. Fish consider that that was merely a local phenomenon. If the dentinal tubes were so permeable, why was it so hard to get cocaine (which was not a very difficult substance to diffuse) into the substance of the dentine? Another point needing explanation was the following: the enamel was much permeated by spaces, but what kind of structure had it which enabled it to retain its enormous crushing strength, in spite of the channels which apparently surrounded the prisms?

He (the President) also asked whether the lymph zone, which might contain something besides lymph, threw any light on the peculiar sensation of the tooth. He always had the idea that the peculiar sensation of dentine was not intended by Nature to make a person look upon the filling of a tooth as a kind of Chinese torture, but was probably a part of ordinary sensation, conveying information to the nerve centres which correlated the movements of mastication. Dentine, being an elastic substance, must yield appreciably to the ordinary pressures of mastication. If there was a layer of sensitive nerve tissue just underneath the enamel, it would probably unconsciously transmit some sort of sensation under the influence of such pressures.

Dr. FISH (in reply) said he would deal first with the President's questions. He had not found that in pyorrhœa the calcium content of the dentine was, as a rule, diminished. The translucent teeth of pyorrhœa often contained the normal amount of calcium. It was perhaps a coincidence that it was a tooth from a severely infected mouth which proved to have the lowest calcium content in the series. The object in mentioning this particular analysis was to show that under some circumstances, as yet not clearly defined, it was possible for calcium to be withdrawn from the dentine, presumably by the lymph stream.

The observation that cocaine was not carried to the pulp from a simple cavity in the dentine by lymph circulation had its counterpart in an experimental observation with methylene blue. It was found that if a cavity was made through the dentine, exposing the pulp, and was then filled with the dye, the dye would enter the pulp and from the pulp would be carried up the tubules. On the other hand it was often noticed that the cavity in the dentine cut across a number of tubules, but, although the cavity was full of the dye, this had not entered the tubules which were thus cut across. The explanation was that the movements of the lymph in the tubules originated from the pulp, and the lymph passed out to the marginal lymph plexus, and from this plexus back down other tubules to another part of the pulp. If, by making a cavity in the dentine, this lymph path were broken, there was no pressure to drive the lymph back to the pulp along the damaged tubules, and only by supplying artificial pressure, as in cocaine anæsthesia with gutta-percha, could one get the drug into the pulp. Very probably the normal response to injury of the dentine would be an outpouring of lymph into the cavity from the tubules, but this would be difficult to observe clinically.

In the course of a few days after the placing of a diffusible drug in a cavity, some would diffuse into neighbouring tubules in which the circulation was intact and so the drug would reach the pulp. If the drug were arsenic it would cause stasis and so would be retained and kill the pulp, but if it were cocaine it would be absorbed and its local action would only be transient. Clinically, this would be of no value, since the drug might reach the pulp at any moment from an hour or two to a week or so after its being placed in the cavity.

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With reference to the presence of actual lymph spaces in the enamel, it seemed very unlikely that they existed there. If the so-called prism sheath, which was found to contain the dye in these experiments, were a lymph space, the enamel would be much less hard and dense than it was known to be clinically. Moreover, in the dentine where lymph spaces and a true circulation had been demonstrated, foreign substances could be shown to move along the tubules in a few minutes. In the enamel no solid particles had been introduced, and even a soluble dye took a number of hours to enter the prism sheaths. The evidence was, therefore, that the lymph merely diffused along a substance which was at least partially organic and which surrounded each prism. To this substance the name of prism sheath or cuticle had been given.

The demonstration of a lymph circulation in the dentine had a very definite bearing on the explanation of sensation in the dentine. It was a matter of common experience that the most sensitive part of the dentine was the most superficial layer and it was significant that this area coincided with the marginal lymph plexus. Naturally, owing to the ramification of the terminal branches, pressure on this plexus would be more readily transmitted along the tubules to the pulp than would pressure on any other part of the dentine.

The relation of sensation in the teeth to the co-ordination of the movements of mastication was being worked out by Dr. David Stewart of Manchester, and he (Dr. Fish) hoped he might be permitted to leave this matter to be dealt with by Dr. Stewart on the occasion of his forthcoming paper before the Section.

In reply to Mr. Livingston, Dr. Fish said that he was satisfied that his experiments showed the presence of body fluids in the enamel and that they entered the enamel from the dentine, since the methylene blue which had been demonstrated in the enamel was dissolved in the body fluids. He would not, however, describe the irrigation of the enamel as a true circulation. On one occasion he had attempted to get methylene blue to enter the enamel from the saliva, but he had failed to demonstrate any of the dye in the enamel. He hoped to repeat this experiment as he certainly would not claim one negative result as proof that there was no possibility of substances from the saliva entering the enamel.

Mr. Turner had asked whether the movements of lymph in the dentinal tubules could be regarded as simple diffusion and not as a true circulation. He (Dr. Fish) said that the presence of particles of pigment in the tubules of his experimental animals showed the existence of a lymph space, and the conditions of the experiment showed that these particles were carried there by some means other than the application of external force. Hence there must be natural movement in the contents of this space—in other words, a circulation of the body fluids along the tubule.

Mr. Turner also raised the question of the analogy between human and dogs' teeth. Dr. Fish felt this to be one of the utmost importance, and referred to the observation of Dr. Percy Howe[1] that lead could be demonstrated in the dentine and enamel of patients suffering from lead poisoning. This was comparable to the speaker's own observation[2] that trypan blue could be detected in the dentine of cats' teeth after it had been introduced into the subcutaneous tissues of the abdomen.

A further piece of evidence was available in that he had transplanted a tooth in a girl in hospital, and two hours after the operation the tooth was seen to have turned grey, owing, presumably, to the existence of blood pigment in the lymph of the tubules following hæmolysis in the pulp. Some weeks later the discoloration had almost disappeared, and it was thought that the resumed circulation in the tubules had washed out the blood pigment.

In reply to Mr. Bulleid's question as to the nature of the prism sheath the speaker referred to his answer to the President's question and to the description given by the late Mr. Howard Mummery. In a further question Mr. Bulleid asked whether calcium was found to be withdrawn from the dentine in cases of arterio-sclerosis. He (Dr. Fish) had not undertaken analysis in these cases, but as a general rule he had noted that the dentine shared the fate of other tissues in which calcium was, or might be, deposited. He would therefore expect an increase in the calcium content of the dentine in cases of arterio-sclerosis if any change occurred at all.

[1] P. R. Howe, "A New Research on Dental Caries," *Dental Cosmos*, November, 1926, No. 11, lxviii, pp. 1021-1033.

[2] E. W. Fish, "Circulation of Lymph in the Dentine," *Proc. Roy. Soc. Med.* 1925, xviii (Sect. Odont.), pp. 35-37.

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Mr. Doubleday referred to the mechanism by which the lymph was caused to flow along the tubules, and while appreciating the possible bearing of the Rouget cells on the problem asked whether the speaker thought the odontoblasts could function in this way. Dr. Fish thought that the function of the odontoblast and its process was one of metabolic control. He had demonstrated a flow of lymph in the dentine and also an active calcium metabolism in this tissue. It was therefore necessary to presume some control over these functions, and the most likely link between the nervous system and the dentine, so far as the control of metabolic processes was concerned, was the odontoblast, which sent a prolongation of its cytoplasm along the tubule to the periphery of the dentine. In referring to the clinical experience of parathyroid extract in pyorrhœa treatment he (the speaker) was interested in hearing that benefit had been recorded, since it had been found impossible to preserve the life of a parathyroidectomized cat by the exhibition of parathyroid extract by mouth, though this result had been obtained by using the hypodermic preparation of Collip.

In reply to Mr. Bayford Underwood, he (the speaker) said that he thought that the lymph entered the organic material of the prism sheath in the enamel by a process of diffusion, and that there was no indication of any actual flow and return along definite paths. The dyed lymph simply appeared to diffuse along the sheaths, and when, as a result of metabolic processes, its composition became altered it would presumably be replaced with fresh lymph by the same process of diffusion.

Section of Orthopædics.

President—Dr. W. T. Gordon Pugh.

Cases.

Unusual Case of Congenital Coxa Vara.

By H. A. T. Fairbank, D.S.O., M.S.

J. F., boy, aged 3¼. Right leg noticed to be short when 4 days old. Considered to be due to birth fracture. When first seen at age of 8 months, the condition was precisely the same as at present, except that the head of the femur was not visible. There has never been any pain. No history of congenital deformity in the family. At 8 months shortening amounted to 2½ in. and is now 4½ in. Shortening confined



Fig. 1.—X-ray photograph showing diminutive femur with bend in upper third of shaft, coxa vara, and no ossific centre for neck.

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to the thigh, the tibiæ being approximately equal in length. The great trochanter on the right side is markedly raised, with great limitation of abduction and internal rotation.

X-rays (fig. 1) shows the right femur to be short and dense, and curved in its upper third, whilst there is a considerable clear interval, over 1 in. in width, between the trochanteric region and the ossific centre for the head. Some rotation outwards of lower end of femur. Extension was applied for a few weeks without producing any difference in the relative position of the shaft of the femur and the head. It is proposed at some time to perform an osteotomy of the femur to correct some of the deformity, though the shortening will always be great. It is presumed that the neck of the femur is present but unossified, since, on rotation of the limb, the trochanter moves forwards and backwards around a centre situated in the head of the bone.

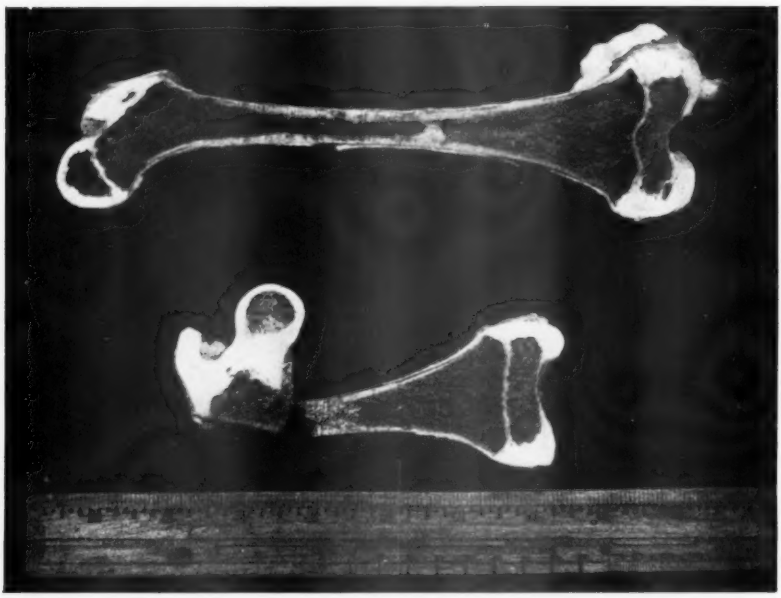


FIG. 2.—Photograph of both femora in section, showing that neck of right femur is formed, but is unossified.

Discussion.—Mr. D. McCRAE AITKEN emphasized the importance of freeing the pelvi-trochanteric muscles before attempting any traction or any bone graft operation.

Mr. PAUL BERNARD ROTH suggested institutional treatment.

Dr. W. T. GORDON PUGH (President) said that this type of case often resulted in amputation.

Mr. H. A. T. FAIRBANK discussed amputation of the foot by the Syme method.

Mr. ALAN H. TODD advocated retention of the foot, in the hope that, if the patient were allowed to bear upon a foot-piece in a prosthetic appliance, the stimulus of weight-bearing might improve the growth and general nutrition of the limb.

Postscript.—Mr. H. A. T. FAIRBANK reported at a later meeting that the child died suddenly at operation. Death was due to massive pulmonary thrombosis. It was found that the neck of the femur (apparently absent in the radiogram) was, in fact, present, though cartilaginous (fig. 2).

Section of Orthopædics 9

Recurring Outward Subluxation of Right Carpo-metacarpal Joint.

By ALAN H. TODD, M.S.

MISS C., aged 27, trained masseuse and medical electrician, fell upon outstretched right hand; since then she has repeatedly suffered outward subluxation of the basal joint of the thumb. When this occurs, she can reduce it, but she experiences severe pain for about half an hour afterwards; the thumb swells, and she can only do her electrical work with difficulty, whilst massage is impossible. Repeated strapping has failed to do good. The case is shown to elicit information as to treatments, successful or unsuccessful, which have already been tried for the relief of this condition.

Discussion.—Dr. W. T. GORDON PUGH (President) said that there were many minor disabilities, such as this, which were not described in books, but were yet a considerable handicap to the patient; many operations were performed for the relief of such conditions, without any striking success.

Mr. H. A. T. FAIRBANK suggested the insertion of a mattress suture of deep fascia.

Mr. D. MCCRAE AITKEN mentioned that in a case of this kind he had found a pad of fat within the joint.

Tuberculous Disease of the Spine.

By D. MCCRAE AITKEN, F.R.C.S.

A. T., AGED 22. Fall at age of 2 years; backache ever since. First seen, 1918, aged 14; kyphosis marked, tuberculous destruction of bodies of several lumbar vertebræ. Straightened considerably on Thomas's frame. September, 1919: Bone graft. 1923: Went to work. June, 1925, readmitted: Deformity much increased, girdle pain, loss of power in lower limbs. Put on Thomas's frame; paralysis rapidly disappeared. October, 1925: Lateral bone graft. February, 1926: Up in long plaster jacket and spica on one thigh. October, 1926: Walking plaster; bone graft getting thicker.

Discussion.—Dr. W. T. GORDON PUGH (President) discussed the case from the point of view of fracture of the graft in the lumbar region.

Mr. D. MCCRAE AITKEN replied that lumbar grafts did well, and that he remembered no case of fracture in that region.

Bony Ankylosis of Interphalangeal Joint of Finger.

By B. WHITCHURCH HOWELL, F.R.C.S.

PATIENT, a girl, F. C., aged 12. September, 1925: Sloughing of extensor tendon and osteomyelitis of the first and second phalanges, following application of carbolic acid for wart on dorsum of finger; joint involved. Splinted until ankylosis took place in extension. Long flexor tendon intact. Treatment proposed: Partial excision of ankylosed phalanges, and reunion in such a way that the last interphalangeal joint takes up the position of the first when the fist is closed. Suture of extensor tendon.

Mr. H. A. T. FAIRBANK advised amputation; he thought that suture of a tendon over an osteotomy was unlikely to be successful.

10 Rocyn Jones: *Scaphoid Tumour: Case for Diagnosis*

Scaphoid Tumour: Case for Diagnosis.

By A. Rocyn Jones, F.R.C.S.

S. M., aged 4 years, 11 months, brought to hospital on account of swelling on inner side of left foot. Mother stated that lump had grown gradually during past nine months. Severe pes plano-valgus and large, irregular, hard mass at side of scaphoid. Radiogram shows all tarsal bones present, and of normal appearance, except the scaphoid, which is represented by a large irregular mass, composed of four segments fused together. Scaphoid has not yet appeared in right foot. Case shown for diagnosis and treatment. It is suggested that the swelling may be a chondroma, although there are no lumps on any of the other palpable bones; or it may be an irregular overgrowth due to trauma; but there is no history of injury.

Mr. George Perkins, F.R.C.S., showed a Case for Diagnosis, ? Angioma of Foot.

Section of Surgery.

President—Mr. V. Warren Low, C.B., F.R.C.S.

DISCUSSION ON THE TREATMENT OF CANCER OF THE ŒSOPHAGUS.

Mr. F. J. Steward.

The treatment of carcinoma of the œsophagus may either be frankly palliative or may aim at cure.

I propose first to deal with palliative treatment, and then to examine the problem of curative treatment.

Palliative Treatment.

Since the outstanding symptom is dysphagia due to mechanical obstruction by the growth, all palliative treatment is directed towards the relief of this symptom. With this end in view the lumen of the stricture may be either enlarged by dilatation with bougies, or maintained of a size sufficient for the passage of fluids by tubes of various kinds, or increased by the destruction of the growth by diathermy or by radium. Finally the stricture may be ignored and provision made against starvation by the performance of gastrostomy.

All these methods are unsatisfactory, some more so than others, but all have their champions. As for myself, I was, as it were, brought up in the atmosphere of tubes, for my first introduction to this work was as clinical assistant to Sir Charters Symonds in the Throat Department at Guy's Hospital in 1896. I saw many cases of carcinoma of the œsophagus treated with Symonds' tubes, and I saw others that were not suitable for the passage of a Symonds' tube, treated by gastrostomy.

Generally speaking, the cases treated by gastrostomy were late cases, and did not long survive the operation, but it seemed to me that the discomforts from which they suffered before they died were, on the whole, less than the discomforts suffered by those who were treated by tubes.

Later, when I had charge of the Throat Department at Guy's Hospital, I gradually used tubes less often, and resorted to a primary gastrostomy more frequently. For many years now, I have not used a tube of any kind for a case of carcinoma of the œsophagus, but have always advised gastrostomy.

In my opinion this question is, in part, a matter of psychology. In the first place there is the psychology of the surgeon. When he is faced by a stricture of some tube his natural surgical instinct is to dilate that stricture, or, at any rate, to do something which will maintain to some extent the natural function of the tube concerned. If he cannot do this, he feels he has failed, and a negative emotional tone results. On the other hand the neat introduction and correct placing of a dilator or a tube in an œsophageal or other stricture is a gratifying proof of his manual dexterity and produces a positive emotional tone.

With regard to the psychology of the patient: the idea of being fed through an unnatural opening is repugnant to him, and the inability to swallow is depressing, therefore he will submit to much painful manipulation rather than have a

gastrostomy made. If, however, shortly after a gastrostomy has been made the patient discovers, as he often does, that he can once again swallow food, he feels that he is getting better, and his mental state undergoes a corresponding improvement.

But, whilst I admit that a tube may give little trouble and may function satisfactorily, this is by no means always the case. Placing the tube in position may be very distressing to the patient and its presence is frequently the cause of a constant gnawing pain, which may become unbearable. Moreover, the repeated blocking of the tube by food or growth, necessitating withdrawal and replacement, is each time a terrible ordeal and the anticipation of the next time is a nightmare.

On the other hand, a Witzel's gastrostomy, if performed as soon as the diagnosis is made, is quite easy to manage after the first fortnight, so that the patient or his relations can administer the feeds without difficulty or discomfort, and can soon learn how to guard against leakage. I know that gastrostomy for cancer of the œsophagus has a bad record and a high mortality. I plead for its early performance as a treatment in itself.

Perhaps, however, the most definite advantage of a gastrostomy is that it is a source of real comfort to the patient and his friends as soon as they realize that it is a sure guarantee against death from starvation. This is more than can be promised when the stricture is treated directly whether by tube, by diathermy or by radium.

As with colostomy for inoperable rectal carcinoma, so with gastrostomy for carcinoma of the œsophagus, the consequent cessation of irritation sometimes results in a quite unexpected lengthening of the period of survival. I know that two of my patients have lived for more than five years after gastrostomy, and there may be others.

Curative Treatment.

Two entirely different means have so far been employed in the attempt to cure carcinoma of the œsophagus—radium and surgical extirpation.

Radium.—Radium has been widely used during the past eighteen years, and a large number of cases must now have been treated, but the results have been disappointing, in so far as actual cure is concerned.

The causes of failure are fairly obvious, but it is difficult to see how they are to be met. The main facts are not in dispute and are as follows:

That radium can destroy carcinoma of the œsophagus is certain, for ulcers and tumours that have been seen through the œsophagoscope, and have been proved by histological examination to be carcinomatous, have completely disappeared after treatment with radium.

But this complete disappearance is exceptional, and the disease usually reappears sooner or later. The explanation appears to be twofold. In the first place variation in the effect of a given dose of radium must be the result of variation in the resistance of the cells or their surrounding stroma to the rays that reach them. It appears to me to be improbable that this variation is accounted for solely by differences in the hardness of the tumour, and I cannot help feeling that there is a further factor that is not recognized at the present time.

In the second place the almost constant relapse after improvement must be due to the too limited radius of action of the radium, in other words, the dose has been too small to destroy the whole growth. This conclusion is supported by the study of published cases, for the best results go with the largest doses.

For instance, Guisez, who has treated 270 cases, has had thirty cases in which the patients survived more than eighteen months, two being free from recurrence ten years after treatment, one, five years after, and four, three years after, while four others died from intercurrent disease. He uses very large doses, 100 to 120 mgm. of radium bromide divided into three tubes placed end to end in a hollow bougie.

This dose is applied every two days for ten to twelve hours and five or six treatments are given. The dose in milligram hours thus works out to more than 5,000, or about three times that used by most other workers. Guisez lays much stress upon the importance of spreading the dose over a wide area with special care to treat the whole vertical extent of the growth. With this object he uses three or more tubes placed end to end in the hollow bougie applicator.

With regard to the future of radium treatment, to my mind the hope of improved results depends upon earlier diagnosis, more exact knowledge of the extent of the disease and more powerful dosage.

Excision.—Excision of a portion of the œsophagus for carcinoma was until comparatively recently only attempted when the growth involved the upper extremity of the tube.

Kappeler made two unsuccessful attempts to remove a growth of the cervical œsophagus in 1875 and 1876, but two years later Czerny removed the upper six centimetres of the œsophagus, and the patient, a woman, aged 51, survived the operation, but died from recurrence rather more than a year later. Many similar operations have since been performed, in some cases with the formation of a permanent œsophagostomy, whilst in others the gap in the œsophagus has been bridged by a skin flap, converted later into a tube. Both methods have had some success, but the operation is necessarily long and difficult and is especially liable to be followed by severe infection of the wound. In most cases, also, starvation has previously undermined the patient's strength. Hence the operation mortality has been high—in a collection of twenty-five cases published by Von Acker in 1908 it was 56 per cent. It should be less now with improved methods.

There remains for consideration the question of operation upon the mediastinal portion of the œsophagus. Although many cases have now been operated upon and much ingenuity has been exercised in devising methods of overcoming the technical difficulties associated with the operation, very few of the patients have survived for more than a few days.

The following factors have contributed to the many failures :—

(1) Rapidly fatal infection of pleura or mediastinum, or both, has been the cause of death in the large majority of those patients who survived the shock of the operation, the source of infection, in most cases, being the œsophagus. In the only cases in which the patients have recovered from the operation, infection was avoided either by extrathoracic treatment of the œsophagus (Torek and Eggers), or by multi-stage operation (Lilienthal), the pleura and mediastinum being shut off by adhesions before the œsophagus was divided.

(2) The œsophagus is so straight that there is no slack when it is mobilized; on the other hand it retracts longitudinally on section.

(3) The structure of the œsophagus, in particular the absence of a serous coat and the softness of its walls, which in consequence will not hold sutures at all well.

(4) Reconstruction of the œsophagus after resection for carcinoma and for cicatricial stenosis offers great difficulty and many plans have been adopted. I need not go into the details of these, but I may mention that the gap has been filled by a rubber tube—in Torek's successful case, also by a tube constructed of skin, or stomach, or jejunum, or transverse colon, and that each of these methods has been successfully employed.

I believe that only three patients have recovered from an operation for removal of a carcinoma of the mediastinal portion of the œsophagus.

The first case was Torek's. The patient, a woman aged 67, was operated upon on March 14, 1913. She had suffered from dysphagia for nine months and had been limited to fluids for six weeks.

The tumour was situated below the arch of the aorta, and was approached by a transpleural

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incision in the seventh left intercostal space. The œsophagus was mobilized, divided by cautery and crushing below the growth between ligatures, and the gastric stump invaginated.

The further dissection presented great difficulty, which was finally overcome by dislodging the aorta and lifting it forwards, after having divided a number of its thoracic branches between ligatures. The tumour, moreover, was attached to the left bronchus, which sustained a cut during the dissection. This cut was sutured with silk. The œsophagus was now delivered through an incision in the neck, the growth removed and the stump carried down subcutaneously and brought through an incision over the second intercostal space and there fixed to the skin.

The wounds were completely closed without drainage. Recovery was uneventful, pulse, respiration and temperature remaining normal after the fourth day. On the eighth day the free end of the gastrostomy tube was introduced into the cut end of the œsophagus at feeding times, and from that time onwards the patient nourished herself by swallowing her food.

On examination of the specimen removed, the growth was found to be 4·3 cm. long and to extend completely round the circumference of the œsophagus. At one spot it reached the surface of the œsophagus as a nodule 1 cm. in diameter. The growth was a squamous-celled epithelioma.

At a meeting of the American Association of Thoracic Surgery, held in June, 1924, eleven years after this operation, Torek [1] reported as follow:—

"The patient, who is now 78 years old, has practically no trouble with the feeding problem. Anything that can be cut or chewed into a finely divided state will readily pass through the tube into the stomach." She was cheerful and happy and enjoying good health. She lived another year and then died of pneumonia after three days' illness at the age of 79, more than twelve years after the operation.

The second case was that of Lilienthal. The operation which he performed he devised and adopted in consequence of the number of fatalities resulting from the exploration of the œsophagus by the transpleural method used by Torek in his case.

Of these fatalities the majority had resulted from infection of the pleura and mediastinum, and in order to lessen the risk of this, Lilienthal decided upon a multi-stage extrapleural operation, division of the œsophagus being deferred until the mediastinum had been sealed off.

The patient, a man aged 34, had had difficulty in swallowing for nine months and was found to have a malignant stricture of the œsophagus two inches above the cardia. The operation was performed on December 16, 1920. A long skin-flap with its pedicle posterior and extending in length from a point 1½ in. to the left of the spine to the mid-axillary line, and in width from the eighth to the tenth rib, was first dissected up. The ninth rib was then resected subperiosteally and the parietal pleura stripped from behind forwards until the structures in the posterior mediastinum could be identified. The sixth, seventh and eighth ribs were now divided posteriorly and the edges of the wound widely retracted. The lower part of the œsophagus with the growth was then isolated, the vagi separated and the skin-flap passed beneath the œsophagus and fixed in position with sutures. The anterior part of the wound was closed, and through the posterior part rubber dam was introduced to cover the pleura, and the rest of the cavity was lightly packed with gauze. There was no shock after the operation and progress was satisfactory. Thirteen days later the growth was removed, no anæsthetic being used, and after a further two weeks the pedicle of the skin-flap was divided and the flap folded in the form of a tube. Certain difficulties arose in connexion with the flap, and there was a tendency to stricture, but eventually the wound healed completely and the patient was able to swallow soft or well masticated food. He died sixteen months later from recurrence.

The third case was that of Eggers.[2] Here the patient was a man, aged 38, with a history of dysphagia of only six weeks' duration. The operation was performed on April 24, 1924, and consisted of a transpleural exploration which disclosed a growth quite near the diaphragm. The further steps followed the lines of Torek's operation, practically the whole

[1] *Arch. Surg.*, Chicago, 1925, x, pp. 353-360.
[2] *Ibid.*, pp. 361-373.

of the thoracic œsophagus being removed. The growth was of considerable size, and adherent to the pleura. The vagi were incorporated in the tumour and were divided without any disturbance being noticed. The patient recovered rapidly and was up on the fourteenth day. He was in good health a year later.

The study of these cases led me to the conclusion that it would be justifiable to attempt operation in an uncomplicated case in which the growth appeared to be small and localized to the œsophagus, provided that the patient was in good general condition and free from visceral disease.

As regards the choice of operation I formed the opinion that for a growth of the lower third of the œsophagus Lilienthal's operation would be more suitable, while for a growth of the middle third of the œsophagus I should prefer Torek's operation.

I have explored an œsophageal carcinoma with a view to removal on three occasions. The patients were transferred to me from the Throat Department at Guy's Hospital, Cases I and II by Mr. Layton, Case III by Mr. Mollison. They were males, their ages being 51, 62, and 53. In all the general condition was good, there was no evidence of vascular, pulmonary, or renal disease and nutrition was not much impaired. In each the growth, so far as could be ascertained by œsophagoscopic and radiographic examination, appeared to be limited in extent, and involving the œsophagus low down, the level being the eighth dorsal vertebra in two cases, the sixth in the third case.

The anæsthetic was in each case intratracheal oxygen and ether administered by Dr. F. E. Shipway, and the result was entirely satisfactory. In the second and third cases a number of the intercostal nerves were blocked with one per cent. novocain solution.

The operation, which was the same in each, except that in the third case the level was higher, closely followed the method adopted by Lilienthal, my intention being to make good the gap in the œsophagus by skin, and to approach the œsophagus through the posterior mediastinum, if possible without opening the pleura.

A thick flap of skin and muscle 4 in. wide and 8 in. long was raised from the chest wall, and about 8 in. of the rib corresponding to the middle of the flap resected. Beginning from behind, the pleura was separated from the chest wall in a forward direction and the posterior mediastinum gradually opened up, four other ribs—two above and two below the one resected—being then divided behind, and the wound widely opened by rib-spreaders. The attempt to strip the pleura without tearing failed in each case, large tears being made in the first and second cases, and a small one, which I was able to close, in the third case.

In this way the aorta and then the œsophagus were freely exposed and the growth could be palpated and its characters ascertained. In the first and second cases, about 2 in. of the œsophagus appeared to be involved, the growth felt hard and circumscribed and did not appear to extend beyond the wall of the œsophagus. In the third case, however, the growth was clearly larger and not so hard.

The vagi and plexus gulæ were next anæsthetized with 2 per cent. solution of cocaine and then separated from the wall of the œsophagus. This proved an easy matter in the case of the left vagus but in two cases the right vagus was involved in the growth and had to be divided.

In the first and second cases the growth, together with the œsophagus above and below it, was further separated, the skin-flap was passed beneath and fixed in position with catgut sutures and the rest of the wound partially closed, the exposed pleura being covered with rubber dam and the cavity superficial to it lightly packed with sterile gauze.

In the third case, although I realized that the growth was more extensive, I attempted, perhaps unwisely, to separate it from the pericardium. In so doing I tore a hole in the right pleura in a position that did not permit of suture and although I quickly filled the hole with gauze the patient's condition became alarming. I therefore rapidly closed the wound.

All three cases ended fatally. In the first the patient rallied well from the operation, passed a good night, and when my house surgeon saw him at 9.30 next morning he said he was comfortable, but he died suddenly shortly afterwards. The post-mortem examination revealed nothing to account for death, and no evidence of secondary growth.

The second patient lived for nine days after operation. He had practically no shock, and an

hour after the operation his pulse-rate was 99 and his blood-pressure 118. He appeared to be doing well for five days and then signs of pneumonia appeared on the right side and he gradually sank. At the post-mortem examination the left lung was found to be almost completely collapsed, and there was hypostatic pneumonia of the lower right lobe. The growth proved to be quite early and limited to the œsophagus. No invaded glands or other evidence of growth were found.

The third patient did not rally from the operation and died within twelve hours. Post-mortem: the right lung was found largely collapsed and left partially so. The growth was adherent to both pleuræ and to the pericardium.

These results, although certainly disappointing, are, I venture to say, in some ways encouraging. In the first place, the diagnosis and selection of cases were very little at fault, for the first and second cases were correctly judged to be suitable for radical treatment. This opinion was confirmed at the operation and again at the post-mortem examination. At the operation the growth appeared to be limited to the wall of the œsophagus, there was no adhesion to the surrounding parts excepting very slight adhesion to the pericardium in Case I, and no infiltrated glands were discovered. The post-mortem examination confirmed the operation findings entirely, for in each case the growth was limited to the œsophagus, there was no glandular involvement and there was no evidence of metastasis.

So also in regard to the third case. The clinical investigations were confirmed at the operation, for the possibility of removal was considered doubtful, but as the patient very much wished it the attempt was made. In the second place, Cases I and II show that the first stage of this operation is not to be ruled out on the score of severity, for shock was not by any means serious, hæmorrhage was negligible, and recovery from the immediate effects of the operation upon respiration and circulation was satisfactory.

As to future prospects, after careful consideration of all the information available I have formed the opinion that as technique improves better results may be looked for.

The following are some of the considerations upon which this opinion is based:—

(1) The symptoms of carcinoma of the œsophagus are straightforward and distinctive, so that correct diagnosis in an early stage is not difficult, neither is it difficult to decide whether any given case is a suitable one for operation.

(2) The disease remains localized to the œsophagus for a considerable time in all cases, and during its whole course in a large proportion. In his Hunterian Lecture upon the treatment of cancer of the œsophagus, Abel gives some interesting figures bearing upon this important point. He quotes an analysis of seventy cases examined post mortem by Helsley, who found that in 64 per cent. the disease was confined to the œsophagus, and no secondary deposits were present in the lymphatic glands or other organs. In another collection of post-mortem examinations by Blauwkuip the proportion is considerably smaller—39 per cent. of 125 cases. There is thus a reasonable chance of cure in case of recovery from operation for the removal of an early growth.

(3) The successful performance of other operations involving the mediastinal portion of the œsophagus, such as operations for fibrous stricture of the œsophagus, and for carcinoma of the cardia, clearly shows that from the point of view of technique excision of a carcinoma of the œsophagus is practicable.

(4) Although so few have been successful the reported cases prove the possibility of cure by operation.

(5) Lastly, it is perhaps not unreasonable to hope that the history of the surgery of other organs may be repeated in the case of the œsophagus.

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THE INTUBATION METHOD.

Mr. H. S. SOUTTAR

said that he felt reluctant to bring before the Section the simple method which he used after the brilliant work Mr. Steward had described, and still more so in that he entirely dissented from Mr. Steward's views as to the operability of these cases. It was suggested that these cases were suitable for operation because no secondary growths were found. But how often did we find a secondary growth within one year after the origin of carcinoma of the breast, and how many cases of carcinoma of the œsophagus survived a year? He had examined eighteen post-mortem records at the London Hospital from each of which it was obvious that the growth had reached an entirely inoperable stage, and the condition found around the œsophagus could only be described as chaotic. The average duration of the symptoms was 4·7 months. He (the speaker) had just reached his own hundredth case of carcinoma of the œsophagus, and the average duration of the symptoms at the time he first saw these patients was 4·8 months. Surely this supported his contention that at the time when these cases were first seen by the surgeon they were already in the penultimate stage of the condition which was found at post-mortem. He did not believe that 5 per cent. of the cases which came to the surgeon were operable. It might be said that the cases came late; but the man who could not swallow came at once. The fact was that dysphagia, usually the first symptom, only occurred at a late stage of the disease. Many of the patients that he had seen had come to him within a few weeks or even days of the appearance of their first symptoms, and even then the condition inside the thorax revealed by the œsophagoscope was staggering. Not only that, but many of the cases examined post mortem had never had any œsophageal symptom and the cancer of the œsophagus was only found by accident. By the time interference with swallowing appeared, operation was out of the question. Even supposing that a few completely successful results after removal of the œsophagus could be pointed to, was the operation as a routine procedure thereby justified? This was not a rare disease by any means. In a very short time he himself—and he was not a throat surgeon—had collected 100 cases through the kindness of his friends. The annual mortality from this condition in England and Wales was 1,600. Moreover, could it be described as a cure if a section of the œsophagus were removed and the patient made unable to swallow? Many would prefer death to an existence on those terms. To make the patient able to swallow comfortably until the end of his life was all that it was possible to do in very many cases.

Intubation (Mr. Souttar continued) by the methods ordinarily adopted aimed only at the swallowing of fluids. In his own method he had provided for the swallowing of soft solids, and, after all, in the normal person, given effective mastication, soft solids were all that the œsophagus carried. He exhibited three of his œsophagoscope tubes of different lengths, 10, 14, and 18 in., which afforded remarkable facility in handling the patient. With one of these in position, the next problem was to pass through the stricture, a delicate piece of work, in which one had to be sure that the stricture itself was entered. He used a modification of Jackson's bougie, and, controlled by the œsophagoscope, in the great majority of cases the bougie would be worked through. This accomplished, the surgeon's troubles were over. He then slid down dilators of increasing diameter, up to 11 mm., over the guide and through the stricture, after which he could pass a tube of reasonable dimensions. The tubes used were of German silver wire, flattened and twisted in a curious spiral so as to prevent regurgitation of the tube. Since this spiral twist

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was introduced he had not had a tube coughed up, which was a common event previously. The results in most cases were satisfactory, and the patient, exercising reasonable precautions, was able to sit down to dinner with his family. The patients were told to have everything minced, because, as a rule, they had defective teeth. The average duration of life in twenty-six cases which he had followed up was 5·3 months. Most of them were between 60 and 70 or over, and, after all, to enable them to swallow food for perhaps a year—one of his patients went on for two years, and several for eighteen months—and to make them comfortable was to do a great deal of good, and compared advantageously with the results of gastrostomy.

Mr. A. Lawrence Abel.

I attribute great importance to dealing with the teeth of patients suffering from carcinoma of the œsophagus. The teeth should be removed (or, if the patient objects to that, all the infected teeth), before either a tube is passed, or radium introduced, or an operation undertaken. I have seen cases of carcinoma in the hypo-pharynx and upper œsophagus in which, at first, operation seemed out of the question, but when the patient had been rendered edentulous, the growth decreased remarkably, and became operable.

The most important factor in gastrostomy is the anæsthetic. Every gastrostomy should be performed under a local anæsthetic. This has been done in a very large number of cases at the Cancer Hospital, and in no instance has there been immediate mortality, or the development of broncho-pneumonia.

There are two accurate methods of measuring the length of a carcinomatous or other stricture of the œsophagus. The patient is first X-rayed in the ordinary way; he takes an opaque drink and is examined by means of the fluorescent screen. Then he is placed either on his right side with the pelvis slightly raised, or suspended in the Trendelenburg position, and while so suspended he is given an opaque drink, and an X-ray plate is exposed during the act of swallowing. If the growth is not more than about one inch in length, and if there is no clinical evidence that it has grown beyond the wall of the œsophagus, it is probably in an operable condition.

I have operated upon three cases through the posterior mediastinum by the method originally suggested by Mr. Wilfred Trotter. In none of these cases was it possible to place the skin flap around the œsophagus, on account of adhesions. In two cases a peri-œsophageal abscess was opened and both patients succumbed rapidly to mediastinitis. The patient in the other case, however, made an excellent recovery from the exploratory mediastinotomy, and lived eleven months afterwards with no inconvenience from the operation. Had the tumour been less fixed I cannot see that the passage beneath it of the flap of skin would have added more than a few minutes to the operation, and no more to the shock or dangers of the proceeding. I think, therefore, that an exploratory posterior mediastinotomy is quite a justifiable undertaking. The anæsthetic which I employ is gas and oxygen under considerable pressure, the wound in the thorax being closed in an air-tight fashion so that the lung never collapses afterwards. In eight cases I have used the Souttar tubes, three patients had an œsophageo-tracheal fistula in a fortnight, four swallowed the tubes straight away, and in one case a mediastinal fistula was formed.

I make a strong plea for further attempts at a radical cure of this condition. The patients tend to go first to their own practitioner or to a special department of the hospital, and by the time the surgeon is called in, it is usually too late to do anything but a gastrostomy. If the patient is to wait until he has difficulty in swallowing soft solids or fluids, then the chance of a cure by radical operation is remote.

Mr. T. B. LAYTON,

as an admirer of the work both of Mr. Steward and of Mr. Souttar, thought there was room for both methods of treatment. That the number of cases in which removal could be attempted was small was shown by the fact that from his clinic in two years he had only been able to find two. Of the other cases of this disease some would be suitable for intubation; and he thought Mr. Souttar's tube was nowadays the best. He referred to the case of a gentleman from the Argentine who, after the insertion of the tube, had been able to spend three months going about this country on a holiday and had then returned to Mendoza under the Andes. There he had died painlessly some six months after the tube had been inserted. Mr. Layton thought Mr. Souttar had no reason to reproach himself because he was not attempting radical cures. He was doing much to alleviate suffering, and there would always be many patients for whom more could not be done. In cases in which intubation was not suitable he (Mr. Layton) favoured gastrostomy under local anæsthesia; but it must be done early or not at all. He urged that once the decision to perform it had been made the operation must be considered one of urgency, not that it need be done that night but that it should be done next day. He agreed with Mr. Abel that the patients in all cases should be made edentulous. He had found the best way to do this was to block the second and third divisions of one fifth nerve with tutocaine, and for the dental surgeon then to remove with the utmost gentleness the teeth on that side. In forty-eight hours the teeth on the other side could similarly be removed. The delay was minimal, and one or more administrations of general anæsthesia did not become necessary.

In conclusion, he would say a few words about the relation of specialist to surgeon in such cases as those on which Mr. Steward had operated. He did not think one should talk about the specialist sending a case to the surgeon for operation. The former should take to the surgeon a larger number of cases than could undergo operation. They should do the endoscopy together, examine the X-rays together, and finally decide between them whether any operation should be done, and if so what operation.

Section of Surgery.

SUB-SECTION OF PROCTOLOGY.

President—Mr. J. P. LOCKHART-MUMMERY, F.R.C.S.

Innocent Tumours of the Rectum and Colon.

PRESIDENT'S ADDRESS.

By J. P. LOCKHART-MUMMERY, F.R.C.S.

TUMOURS OF CONGENITAL ORIGIN.

Hypertrophied Papillæ.

Nævi.
Cirsoid aneurysm or cavernous nævus.

Dermoids.
Post-sacral, pre-sacral, containing glioma cells and ciliated cells.

ACQUIRED TUMOURS.

Warts.
Villous and papillary.
Infective papillomata.
Tuberculide.

Fibroid Polyps. These probably arise most frequently from strangulated piles.

Lipomata.

Adenomata.
Single.
Multiple.

Adenomyomata.

Chordoma.
,, *Sacro-coccygeal.*

Carcinoid.

THE word "innocent" in this connexion is somewhat of a misnomer, and it is only in a comparative sense that its use can be justified. Few, if any, tumours of the rectum are innocent of causing trouble to their possessors, and very many, indeed the most common, of so-called innocent tumours of the rectum are potentially malignant; in fact, one of the great advances of modern surgery has been the recognition of this and the ensuing practice of removing wherever possible all innocent tumours at the earliest opportunity. I am convinced that many valuable lives have been saved by this means, and in the future it will have wider application as our diagnosis of these conditions improves.

We have to-day in this room one of the most complete, if not *the* most complete, collection of these tumours that has as yet been collected in any one place, and these specimens will speak for themselves far better than I can hope to do for them. I shall not, therefore, attempt to deal exhaustively with the pathological side of these so-called innocent tumours, but confine my remarks in the main to the clinical rather than to the pathological aspect, hoping that the few remarks I am able to offer will give rise to one of those valuable discussions for which this Sub-section is famous.

Hypertrophied papillæ are found at the white line of Hilton and are the remains of the membrane which, in embryonic life, separated the hind gut from the proctodeum before these structures joined to form the rectum. As a rule, this membrane entirely disappears, but in some 24 per cent. of persons a slight trace remains and can be detected with the proctoscope. Occasionally, these papillæ become considerably hypertrophied and give rise to fibrous polyps. The usual number of such polyps varies from one to three.

Nævi are very infrequent in the neighbourhood of the rectum, and, as a rule, are unimportant. An exception, however, must be made in the case of cirsoid or cavernous nævus. This is a very rare condition, of which I have only seen two cases. In both, the tumour involved the whole rectum and a large part of the sigmoid flexure. The vessels were nearly as large as the little finger, and alarming attacks of bleeding occurred periodically, which threatened the patient's life. My own patient was about 48 when he died, in Paris, from sudden hæmorrhage. The other case, pictures of which I shall be able to show you, occurred in a girl aged 15 under the care of Dr. Bensaud, of Paris. An attempt was made to do something by means of a laparotomy, but, on exposing the tumour, it was obvious that any interference would be fatal, owing to the enormous vessels which were feeding it.

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Post-sacral dermoids more often present themselves as coccygeal fistulæ. They were for a long time a great puzzle to surgeons. These fistulæ always arise in the same spot, over the tip of the coccyx at the point where the post-anal dimple is sometimes found. If treated in the ordinary way, by being incised, they fail to heal. It was first pointed out by Sir John Bland-Sutton that they are congenital and due to a sequestration dermoid. Careful examination will show the epithelial lining and frequently reveals hair growing from the interior of the fistula. There are several specimens here this afternoon showing such fistulæ with hair growing from the interior. A diagnosis can be made from the fact that the main track of the fistula leads towards a point opposite the tip of the coccyx. Successful treatment consists in complete excision of all parts of the fistula. If any of the epithelial lining is left behind, the wound will not heal.

There are several kinds of pre-sacral dermoids. These cysts are situated immediately in front of the sacrum, between it and the rectum. They often overlap the rectum on either side to a considerable extent and displace it forwards. The removal of these dermoids is a very difficult operation. What often happens is that someone opens the dermoid, thinking he is dealing with an abscess, with the result that suppuration occurs. I have now in hospital a woman who ruptured one of these dermoids during the second stage of labour. As a rule, when one is called upon to deal with these cases there is already a long track leading to the remains of the cyst and discharging pus freely. Removal of such dermoids is difficult enough, but their removal after they have been incised and have suppurated is a very serious matter, and I know of no more difficult operation. Successful treatment, however, necessitates complete removal of every portion of the cyst, and unless this is achieved not only will the suppuration go on indefinitely, but in course of time some part of the cyst wall is liable to undergo malignant change; at least I have seen one case in which this took place. The correct treatment is to make an extensive excision and laboriously remove every portion of the cyst. The fact that the wound is septic does not render a good result any easier. These pre-sacral dermoids occur in a number of varieties. They may contain hair and teeth, but those of the most common variety are simply lined with squamous epithelium and filled with pultaceous matter. In a few the cyst is lined with ciliated epithelium and we must assume that it originated from the structures forming the central canal of the spinal cord. In one tumour which I removed some years ago from a patient in St. Mark's Hospital, the cells lining the cyst resembled glioma cells of the brain. Cases have been described in which long locks of hair grew from the lining of the tumour and, protruding from the patient's anus, had to be clipped periodically—shingled, in fact. Several instances of teratoid tumours of the rectum have been described, in which, as might be expected, the contents were very mixed.

There are several different kinds of *warts*. Those of the more typical variety were ascribed to gonorrhœa, probably wrongly. These warts are thin, whitish processes rather like seaweed, growing around the anus and often attaining a considerable size. The other less common variety shows a raised nodular surface which is hard. This nodular variety often covers an extensive area and may be mistaken for epithelioma. A patient in St. Mark's Hospital during the war had this variety of wart over an area nearly as large as a soup plate. It was eventually cured with nitric acid, but it took many weeks to burn away all the warts. My experience of these warts is that the most successful treatment consists in cutting them away as far as possible and then, as they recur, burning them down with fuming nitric acid. Although this sounds painful, yet it is both painless and effective.

Infective papillomata are really included under the heading of warts. They may be due to a great variety of conditions, most of which are obscure. A *primary chancre*

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really comes under this heading, and some of these papillomata, which are not syphilitic, closely resemble chancres, and on microscopical examination may be found to contain spirochætes. Recently I had a patient suffering from one of these infective papillomata, who in the course of a few months developed an epithelioma in the base of the previously innocent papilloma. It will therefore be seen that these conditions are not always so harmless as they appear to be.

Another condition which is included under the heading of warts is *tuberculide*. This is a very rare form of tubercle found at the anal margin; it, too, is generally mistaken for an epithelioma. The tuberculide is a small, raised, flat, white papilla and it very closely resembles an epithelioma in appearance. A specimen is shown here to-day.

Lipomata in connexion with the rectum are rare, but several cases of lipomata of the colon have been described. They have generally been detected owing to their liability to give rise to intussusception.

Fibroid polypi are fairly common, and a great many varieties are met with. Fibroid tumours of the large bowel appear to originate most frequently as the result of some form of injury. Thus, fibroid polypi at the anal margin usually arise from strangulated piles. The pile probably becomes strangulated and eventually is returned into the rectum, where, as the result of inflammation, it slowly becomes converted into fibrous tissue. Such fibroid polypi tend slowly to increase in size. I have seen some of them as large as pigeons' eggs. I have occasionally seen a fibroid polypus originate as the result of the injection treatment for piles. Very occasionally a hypertrophied papilla becomes enlarged into a polypus. In the colon fibroid polypi are often found associated with chronic strictures, and there is a beautiful specimen in St. Bartholomew's Hospital Museum of a simple fibrous stricture of the transverse colon with long filiform polypi growing from its immediate neighbourhood. Again, in cases of hyperplastic tuberculous stricture it is very usual to find large numbers of polypi associated with the stricture; exactly how these arise is at present rather uncertain.

By far the commonest variety of innocent tumour met with in the neighbourhood of the rectum or colon is an *adenoma*. Adenomata occur in two main varieties. They often occur as single, small tumours, which may grow to a very considerable size and are then called villous tumours or papillomata, and a great variety of specimens of this condition are shown this afternoon. They give rise to considerable bleeding and much mucous discharge. When examined they are quite soft and often cover a very considerable area of the rectum. In my experience they are more often sessile than pedunculated. I once removed three such tumours from one patient; two of them in the rectum and one in the pelvic colon, each tumour being as large as an orange. Free removal of a large villous tumour often gives rise to considerable difficulty. In view of the tendency these tumours exhibit to undergo malignant change, they are best treated by complete resection of the rectum, but patients frequently refuse to submit to such an operation for a condition which is not yet malignant, and so I have often removed the tumours by a local resection, with restoration of the bowel. These operations may be very difficult, and I have found the best way of tackling them is to remove the coccyx and lay open the rectum from behind. The tumour is then removed with ½-in. of healthy tissue and the bowel is carefully sewn together again, proper drainage being provided both by the anus, either by means of a tube or by division of the sphincter muscle posteriorly, and by a wick drain at the back. Such cases do very well and complete restoration of function results. The patients require, however, to be kept under supervision at least three years afterwards, so that any sign of recurrence can be immediately dealt with. My own practice is to see such patients every three months, and if there is any sign of recurrence to burn the growth away with fuming nitric acid, or the actual cautery. I have one patient at

the present moment who was operated upon in this way over twenty years ago. So frequently are adenomata found associated with cancer that for some years past we have carefully looked for them in all cases of cancer of the bowel, and we have found associated adenomata in nearly all the cases. It seems very probable that all cancers of the rectum and colon arise in the first instance as simple adenomata, but this is difficult to prove. A paper was read before this Sub-section during last Session by Dr. Dukes[1] on this subject, and several specimens illustrating this association are being shown here to-day. I am convinced that any adenoma in the rectum, however small, should be looked upon as a pre-cancerous condition, and that a patient who exhibits such adenomata should be most carefully watched, and the adenoma removed immediately. I have often noticed that where an adenoma is removed from one part of the rectum, within a few months another one arises in a different part. It seems that the formation of adenomata is an early stage in the development of cancer. Why some adenomata should become cancerous at a very early stage, while others grow into enormous tumours before becoming cancerous, we have no means of ascertaining at present.

Another variety of adenoma is *multiple adenoma*, or, as it has sometimes been called, *adenomatosis* or *colitis polyposa*. This condition appears to be a familial disease. The number of polypi which may be present in one individual runs into hundreds of thousands, and the entire bowel may be packed with them from the ileo-cæcal valve to the anus. The great majority are very small, but some may be as large as pigeons' eggs. We have three families, members of which attend St. Mark's Hospital at the present time, exhibiting this condition. In two patients, both young women, I have carried out a complete resection of the whole colon for this condition and one of the specimens is exhibited here to-day. Both these patients are in quite good health, and, indeed, one of them has increased in weight. The tendency to malignant disease in these cases of multiple adenoma is greater than with ordinary single adenoma. All the patients that I have been able to trace so far with this condition have died from cancer before the age of 50. One patient who was under my care at the hospital had no less than three primary growths in the colon at one time. The only treatment that seems to me likely to be of benefit in these cases is a complete colectomy, admittedly a serious operation, but well worth doing to save the patient dying from cancer at an early age.

Adenomyoma is a curious tumour which is associated with the presence of chocolate cysts of the ovaries, and appears to arise from endometrial cells escaping into the peritoneal cavity by way of the Fallopian tubes during menstruation. Why it only occurs very occasionally is at present one of the mysteries of pathology. It would appear that some of the endometrial cells become grafted upon the ovaries, where they produce chocolate cysts, and that others fall to the bottom of Douglas's pouch, where they grow in the form of a tumour. The tumour involves the bottom of Douglas's pouch, the back of the uterus and the front wall of the rectum. Microscopically, they show a mixture of adenoid and fibromyomatous tissue similar to the wall of the uterus. These tumours may reach a considerable size, and in one case I had to perform a complete abdomino-perineal resection and remove the whole rectum for this condition. This specimen is now in the Museum of the College of Surgeons and it shows three large tumours almost completely blocking up the rectum. We have recently had three cases of this condition at St. Mark's Hospital. They were originally mistaken for carcinomata, but the absence of any ulcerative surface in the rectum led to a correct diagnosis in two cases before proceeding to operation. It is believed that these tumours may be made to retrogress by inducing an artificial menopause, and in one case I removed both ovaries, with the result that the tumour

[1] *Proceedings*, 1926, xix (Sect. Surg., Sub-sect Proct.), p. 8.

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appears to be rapidly disappearing. In another case we tried, unsuccessfully, to bring about this result with radium and I propose to carry out an oöphorectomy in this case also. I certainly think this is the correct treatment, as the removal of the tumour itself would be a most formidable operation.

Chordomata constitute a rare form of tumour arising in the remains of the notochord. They generally appear as small nodules between the rectum and the coccyx. They are not of much clinical importance except that they occasionally give rise to a malignant tumour resembling sarcoma. So far only about four cases have been reported.

Sacrococcygeal chordoma is probably the same condition. These tumours are supposed to arise in notochordal rests. They are encapsuled, are of a soft, jelly-like consistency, and are easily mistaken for a cyst. A recently recorded specimen weighed 13 lb. They are undoubtedly malignant, but tend to grow very slowly. The only case that I know of which has been described in this country was one recorded by Professor Stewart of Leeds. The patient was a man aged 65; the tumour was removed, but recurred ten years later with a fatal result.

Lastly, I record a rare form of tumour met with sometimes in the colon at the ileo-cæcal valve. This has been called *carcinoid*, and a very interesting specimen is shown here to-day, which I removed from an old lady aged 75. The tumour resembles a rodent ulcer of the skin, and appears to be about half way between an innocent and a malignant tumour. It does not give rise to any ulceration on the surface, but spreads in the submucous tissue. It seems to have but little tendency to recur, and if removed the prognosis is eminently favourable.

I have by no means exhausted the subject of simple tumours of the large bowel, and I am afraid there is very much that I have left unsaid, but I do not wish to exhaust your patience by a long paper, but rather to suggest subjects for discussion.

Discussion.—Sir CHARLES GORDON-WATSON said that the subject of the Presidential address was so vast that he proposed to limit his remarks to adenomata of the rectum and adenomyomata of the recto-vaginal septum.

No doubt, as the President had stated, many carcinomata of the rectum began as simple adenomata, and the importance of regular inspection of cases after local removal of adenomata could not be too much emphasized. He (Sir Charles) could instance several cases in which neglect in that direction had had serious consequences. On the other hand there was no doubt that carcinoma did arise *ab initio* as carcinoma in the rectum, though unfortunately it was rare for the early growth to be recognized. It was always a difficult problem whether or not to excise the rectum for a very small and early malignant growth, especially in the case of an adenoma which showed early malignant changes. It required courage to advise a radical operation in these cases, but if we were content with a local excision we might live to regret it. His practice had varied in this respect and he was not prepared to make a dogmatic statement on the matter.

With regard to the villous growth which involved a large area of the rectum and often completely encircled the bowel he would show on the screen two examples of extensive growth involving 4 to 5 in. of mucosa in the long axis and encircling the bowel. He had removed these at St. Mark's Hospital by a sacro-anal method. He first exposed the rectum from behind after removal of the coccyx and then mobilized the rectum. When possible, he had pushed up the reflection of peritoneum but did not hesitate to open it when necessary. After free mobilization the bowel was drawn down through the dilated sphincters subsequently to removal of the anal mucosa and then sutured to the skin margin. In the two cases shown he had secured a good functional result. In other instances when the villous growth involved the lower portion of the rectum he had removed as much as 5 in. of the rectal mucosa by gradual dissection without interfering with the muscular coats—a method which might be described as a magnified Whitehead operation—the upper end was sutured to the anal margin. A specimen from an operation by this method was exhibited on the table. He was inclined to believe that the villous tumour which spread along the surface of the bowel was essentially innocent and differed in this respect from the sessile and nodular adenoma.

He had been much interested in adenomyomata involving the recto-vaginal septum and would show on the screen a diagram illustrating the different sites at which these peculiar growths had been found. They were of especial interest to the rectal surgeon when met with in the recto-vaginal septum. A diagnosis could usually be established by the situation of the lump just behind the posterior fornix, by absence of involvement of the mucosa, and by the fact that pain occurred on defæcation during the menstrual period.

He had on two occasions successfully treated early adeno-myomata at the upper end of the recto-vaginal septum by implantation of radium needles through the posterior fornix. It was important to know that these cases responded to radium and did not give rise to metastasis. If left alone they grew rapidly and became locally malignant, spreading into the broad ligament and across the pouch of Douglas, and often involving coils of intestine. In these instances surgical measures for relief, even if possible, might involve serious risks. In a case of this nature seen with the late Dr. Herbert Williamson, deep X-ray treatment had proved very successful in diminishing the mass and relieving symptoms. In reported cases, both pan-hysterectomy and excision of the rectum had been carried out for the cure of adenomyoma in this situation. He would emphasize the point, however, that whenever possible radium and X-rays should be given a fair trial before heroic surgical measures were advocated.

Dr. CUTHBERT DUKES said that amongst the collection of pathological specimens in the room almost every variety of innocent tumour of the large intestine was represented. He referred to two cases of multiple neurofibromatosis of the large intestine recently reported in *Virchows Archiv* (261 Band, 1 Heft). In speaking of the nomenclature of intestinal tumours he pointed out that the words papilloma and polyp were gross anatomical terms giving no information as to minute structure or function. They were useful for describing what was seen with the naked eye, but if, on microscopical examination, the tumour was found to be a glandular one, it was more accurate to speak of it as a papillomatous or sessile adenoma, or as a pedunculated adenoma. He referred to the difficulties which beset the histological examination of tumours of the rectum and neighbourhood owing to infection with bacteria from the bowel.

Mr. LIONEL NORBURY mentioned a case of a large pedunculated adenoma of the rectum in which, after removal by ligature, early malignant changes were found in the base. After treatment by radium, induration soon became evident at the site of operation. The rectum was subsequently removed by perineal excision.

Radium appeared to stimulate the growth, and in such a case it was wiser to remove the rectum as soon as a definite diagnosis of malignancy had been obtained by microscopical examination. He also mentioned a case of villous papilloma of the rectum in a female patient, aged 44, in which a profuse watery discharge was present; such a discharge being common in this class of case. The tumour was removed locally and proved to be a simple growth. Recurrence soon occurred locally and this was excised, no malignant change being found microscopically. A course of modified deep X-ray therapy was employed with no further recurrence after nine months. He advised X-ray treatment after removal of such tumours.

Intramural Abscess of Colon Simulating Carcinoma and Secondary to Adenoma.

By Sir CHARLES GORDON-WATSON, K.B.E., C.M.G., F.R.C.S., and CUTHBERT DUKES, O.B.E., M.D.

I.—Sir CHARLES GORDON-WATSON.

DURING the night of December 5, 1925, a woman, aged 45, was seized with severe abdominal pain in the right iliac fossa accompanied with nausea and extreme tenderness.

On the following day I removed an acutely inflamed appendix. When examining the abdomen, before operation, I felt a hard and movable lump in the epigastric region, which I investigated after removing the appendix. The lump proved to be in the wall of the transverse colon and it had the naked-eye appearance and the feel of

a scirrhous carcinoma; I had no doubt then that it was such. There were no adhesions and the lump was easily delivered for inspection.

I hesitated to embark on a primary resection during an attack of acute appendicitis, and so I performed a lateral anastomosis between the proximal and distal ends of the transverse colon and closed the abdomen.

A fortnight later I re-opened the abdomen and resected the tumour. Much to my surprise I found that numerous adhesions had occurred round the tumour and that there was much evidence of active inflammation around the involved lump, which made the operation more difficult than I expected. Recovery was uninterrupted.

I handed the specimen to Dr. Dukes unopened.

II.—Dr. Cuthbert Dukes.

The Pathology of the Lesion.

The piece of transverse colon sent for examination measured 5 in. in length. The middle third was occupied by a tumour which bulged into the lumen of the bowel, but the mucous membrane was not ulcerated at any point. The tumour was 1½ in. in diameter and about ¾ in. in depth. A pedunculated polyp surmounted its summit and stood like a solitary tree on the top of a hillock. On making a transverse section of the tumour an abscess cavity ½ in. in diameter was found in the muscular layer of the bowel wall and was occupied by greyish pus and fæcal concretions; its walls were composed of dense connective tissue. A piece of omentum was adherent to the bowel wall limiting the outer side of the abscess. A narrow track ran down from the base of the polyp into the abscess cavity and along this track a probe passed easily. The drawing shown exhibits these relationships.

Theory of Origin.

The origin of the solitary abscess in the bowel wall can, we think, be explained in the following way:—

An area of chronic inflammation exists around all simple tumours of the bowel in their early stages before a long stalk has developed. The irritation caused by the friction between the sides of the tumour and adjacent mucous membrane leads to a condition of catarrh round the neck of the polyp—"collar catarrh." One of us (C. D.) has recently drawn attention to this fact, and pointed out that in the sulcus surrounding a simple tumour a mass of necrotic material is always visible,[1] and that often evidence of chronic inflammation is to be found in the widely dilated blood-vessels, cellular exudate and masses of lymphoid cells which adjoin the inflamed area. In the case we are reporting we think the abscess originated from the irritation caused by the pedunculated polyp. Bacteria from the bowel infected the inflamed area round the neck of the polyp and caused an abscess in the neighbouring tissue—an abscess which burrowed into the submucosa and bowel wall, and was connected by means of a fistulous track with its site of origin at the base of the polyp.

Comments.

The attack of appendicitis was a blessing in disguise. Perforation of the intramural abscess of the colon was narrowly avoided.

This very rare condition, as in some cases of diverticulitis, illustrates the difficulty of making a certain diagnosis between inflammation and new growth, and the mistake of making a declaration as to the diagnosis before the pathologist has made an investigation. Further, as illustrating a rare complication of an innocent tumour of the colon, the case seems worthy of record on this particular occasion.

[1] See *Brit. Journ. Surg.*, 1926, xiii, pp. 720-733.

Section of Therapeutics and Pharmacology

President—Dr. GEORGE GRAHAM.

The Treatment of Gout.

PRESIDENT'S ADDRESS.

By GEORGE GRAHAM, M.D.

I HAVE chosen the subject of the treatment of gout for the following reasons: First, there is an impression that gout has become a rare disease, whereas I believe that, although much less common than it used to be, it still occurs fairly frequently. During the last two years I myself have seen ten cases in the Out-patient Department at St. Bartholomew's Hospital. Some of these patients were in the middle of an acute attack, but the majority had been ill for a long time, and were suffering from a chronic joint trouble which had usually been diagnosed as rheumatoid arthritis. Secondly, because of the improvement in the condition which has taken place as a result of treatment with cinchophen. Thirdly, because of some unpleasant symptoms which have occurred after cinchophen has been given.

DIAGNOSIS.

Before I speak of the details of treatment I must discuss the diagnosis of the condition.

(1) The family history is of very great value, since a history of typical attacks of gout in other members of the family make it probable that an atypical joint lesion is due to gout. (2) The actual history of the first joint symptoms in a chronic case is of great value. The first attack may be a typical one, involving the big-toe joint, although the subsequent attacks may only affect the hands or knees. (3) The diagnosis of gout is easily made clinically when the big-toe is affected and also when the carpo-metacarpal joints of the index and ring fingers of the hands are involved; but it is much more difficult when the knees, ankles, wrists or shoulders are affected. (4) The shape of the joints is nearly always asymmetrical and this point is of use in making the diagnosis from subacute infective arthritis, where the joints are uniformly swollen. (5) The presence of tophi in the ears, or swellings of the bursæ, are of great assistance, but they do not often occur. (6) The changes which take place in the bones due to the deposit of sodium biurate make the skiagram of great value in the diagnosis. Sodium biurate, unlike a calcium salt, is not opaque to the X-rays, and when sufficient calcium has been displaced by sodium biurate, a clear area will be seen in the plate. These changes are very obvious in the long-standing cases, but are rarely seen after only one attack. The changes are best seen in the small bones of the hands and feet, whereas it is rare to detect the changes in a knee-joint, because of the great thickness of the bone. I have never seen typical changes in a knee-joint and only once in a shoulder- or hip-joint. Phillips, Pomeranz and Pincus [1], in an analysis of 100 cases, saw typical changes in one knee-joint, three hip-joints and ten shoulder-joints.

Fig. 1 (p. 2) shows the changes in a case of moderate severity.

The changes in the bones must be distinguished from three other conditions. In the skin disease, lupus pernio, changes occur in the bones which are identical with those of gout. In the arthritis which occurs in association with psoriasis the changes are suggestive of gout.

One such case I saw with Dr. Geoffrey Evans and thought was due to gout because the skiagram showed some small punched-out areas in the terminal phalanges. It was not until psoriasis of the nails developed that the correct diagnosis was made.

I have been shown the skiagrams from a case of multiple enchondromata of one hand in which the appearances did resemble those of very severe gout but the clinical



FIG. 1.

appearances were quite unlike those of gout (Mr. J. P. Ross, F.R.C.S.). Further, the changes must be distinguished from those due to a long-standing subacute infective arthritis. In these cases there is a general loss of calcium and the bones do not cast a good shadow, but no punched-out areas occur. (6) The estimation of the uric acid in the blood is sometimes of great assistance in a doubtful case. In normal persons the uric acid is usually below 3 mgm. per 100 c.c. of blood, but it is raised

in certain diseases. If a patient is suffering from a chronic nephritis with urea retention the uric acid is always increased. If the patient has a leukæmia, the blood uric acid is also increased. There are also a certain number of people whose blood uric acid is over 3 mgm. per cent. although they have never had an attack of gout. Still, it is probable that if the patient has a joint lesion and a raised blood uric acid, the condition is due to gout. Unfortunately some patients with typical gout do not have raised blood uric acid. Folin [2] watched such a patient and found that the blood uric acid increased when the attack was coming on. Gudzent [3] has found that the blood uric acid was low in 30 per cent. of his cases of gout and he has also observed that the uric acid increased before an attack. It follows that a high figure for the blood uric acid is strongly in favour of gout while a low one does not negative the diagnosis.

Treatment.

The treatment of gout may be divided into: (1) Treatment of the acute attack; (2) prevention of the attacks; (3) treatment of the chronic joint lesion.

(1) *Treatment of the Acute Attack.*

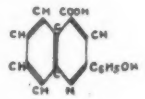
The first essential in the treatment of the acute attack is that the patient shall rest the limb in question properly. If the attack is severe, there is no difficulty about this, but if it is not very severe many patients want to keep about and continue their work. If the lower limb is affected rest in bed is indicated, but if the upper limb is involved, it is usually sufficient to put it in a sling with or without a splint. If the patient is in bed, a cradle must be used to take the weight of the bedclothes off the toes. Local applications, like lotio plumbi, help to relieve the pain. The drug which acts best is colchicum, either the tincture or the vinum. This should be given in a dose of either 15 to 20 minims every four or eight hours as soon as the attack commences. The active principle of colchicum, colchicine, in doses of $\frac{1}{100}$ to $\frac{1}{50}$ gr., is said to give good results, though I have not used it myself. I know of two men who always carry about a colchicum preparation, when travelling, so that it can be taken as soon as an attack starts, a delay of some hours thus being avoided. The mode of action of colchicum is not understood. It has no effect on the excretion of uric acid but it certainly relieves the pain and cuts short the attack. Although colchicum is so potent, it is of no value in preventing attacks. It possesses the somewhat serious disadvantage of causing unpleasant symptoms. There may be only one symptom, namely, pain after meals, but the taking of colchicum, if persisted in, may set up a more severe dyspepsia. Sometimes it will cause diarrhœa. A man, to whom I shall refer later, who has great destruction of the bones, can never take colchicum at all as he vomits at once. On one occasion I gave him a preparation of cinchophen which contained some colchicine. He vomited the next meal and stated that he had been given colchicum. Cinchophen is also of value in the acute attack, but I will speak of its action later on.

In the prevention of the attack, diet plays a great part. In the past, the dietetic restrictions have been very severe, so severe that it was difficult for the patient to continue treatment, but at the present day it is much more lenient. The most important one is the abstinence from all foods which contain large amounts of nucleo-proteins, which are the precursors of uric acid, that is, the avoidance of all gland organs like sweet-breads, kidney and liver. Meat and fish do contain purins but in much less quantity. Beef contains more than mutton or game, and if it is desired to make the diet very strict, this should be avoided. More important is the reduction in the total protein, which should not exceed 60 to 80 grm. per diem, corresponding to 10 to 12 grm. of nitrogen. One of the recommendations of the past

was the avoidance of sugar, although starch was permitted in bulk. It is difficult to understand this recommendation, unless the patient also has a low sugar tolerance. Tea and coffee, which were once forbidden, are now usually allowed. The total caloric requirements must be sufficient for the patient's normal activities and to maintain weight. Although gout is usually associated with overeating in general, it does occur in thin, spare people. Alcohol in various forms is, undeniably, a contributory cause of gout, though its mode of action is quite unknown. Widal and his co-workers [4] have found that patients with gout will often give skin reactions when tested out with different wines. Of nineteen cases, three gave very intense reactions, thirteen feeble ones and three none at all. Of the controls, twenty-eight gave negative tests, two gave positive tests with several wines and three with only one wine. One lady, who gave an intense skin reaction with burgundy, always had an attack of gout after drinking it. Widal could not discover what made burgundy so potent when the wine from a neighbouring district caused no symptoms. The red wines of Burgundy were the most potent, and, curiously enough, port wine, which has the worst reputation in England, did not give any skin reactions. Beer and champagne are both considered to be very potent in this country. Spirits do not affect the patients. The general health must be cared for and all sources of sepsis,—teeth, tonsils, &c.—should receive the same careful attention which they do in any disease.

(2-3) *Prevention of the Attacks and Treatment of the Chronic Joint Lesion.*

In the prevention of the attack and in relieving the chronic joint condition the drug which is most valuable is cinchophen, which is sold in England under the various proprietary names, atophan, agotan, phenoquin, quinophan. This substance, first made in 1887, has the formula



and is a derivative of quinoline, 2 phenyl, 4 carboxylic acid.

In the United States of America, the laboratory of the American Medical Association [5] has carried out an analysis of the different preparations of cinchophen made by six different firms and found that they were all equally pure. The price, however, varied from 17/6 to 3/6 per 50 grm. In this country the preparations have not been tested by any central laboratory. The price varies from 15/- to 6/6 per 50 grm.

It was introduced into medicine by Nicolaier and Dohrn [6], who showed that it caused a great increase in the output of uric acid in the urine of healthy persons but especially in patients with gout. There has been, and still is, a dispute about its mode of action. Some workers have thought that it increases the purin metabolism and so causes a greater output of uric acid, whereas others have thought that it enables the kidney to excrete more uric acid. A great advance was made in this dispute when Folin [7] introduced a relatively simple method of estimating the uric acid in the blood. Folin and Lyman [8] thought that the "extra" uric acid in the urine came from the blood, but a calculation of the total amount of uric acid in the blood showed that this could only supply about one-tenth of the uric acid excreted in the urine. I made a communication on this point to this Section in 1920 [9].

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The patient was under the care of Sir Archibald Garrod in the ward of the Medical Unit at St. Bartholomew's Hospital. He had very severe gout; the bones of the hands had been largely destroyed by deposits of sodium biurate and two fingers had been amputated in 1915. He had abundant deposits of sodium biurate elsewhere in the body. He was given a purin-free diet and after a control period was given 20 gr. of cinchophen, three times a day for four days. The uric acid output in the control period was about 0·22 grm., instead of the usual 0·5 to 0·7 grm. The blood uric acid was 4·5 mgm., but this was estimated by Folin's old method which gave somewhat lower results than the new methods (Benedict [22], Folin [23]). The increase in the uric acid output was very striking, as it rose to 0·58 grm. on the first day and fell to 0·45 grm. on the third day. On the fifth day it rose again to 0·75 grm. although the cinchophen had been stopped, and then rapidly to 0·30 grm. per day and remained constant, about 0·1 grm. higher than in the control period (fig. 2). The blood uric acid fell to 2·9 mgm. per cent. on the fourth day. The extra uric acid excreted in the three days was 0·84 grm. and in the next three days 1·06 grm., so that the man excreted 2·9 grm. more uric acid in six days than in the control period. The total uric acid in the blood before the experiment was 0·18 grm. and after the third day was 0·116 grm., a loss of only 0·064 grm. in contrast with 0·84 grm. in the urine.

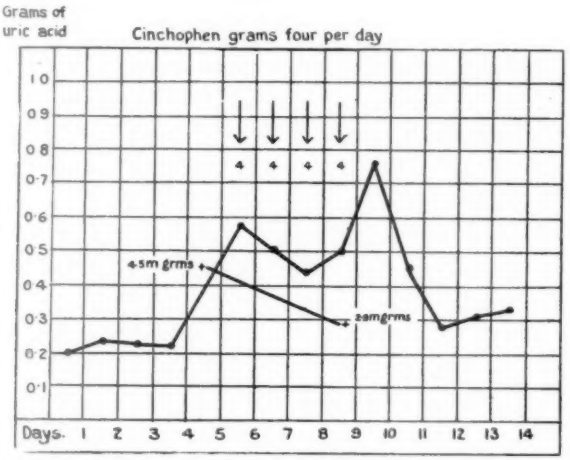


FIG. 2.—Represents the effect of cinchophen. The abscissæ represent the days of the experiment. The ordinates represent the grm. of uric acid. The uric acid excreted in the urine is represented by ●, the uric acid in the blood in mg. per cent. by +. The cinchophen was given at ↓.

It was shown originally by Sir Alfred Garrod [10] that uric acid was contained in blister fluid, pleural fluid, and was spread all over the body. This has been confirmed by the new methods, and Fine [11] found the following figures (Table I) at the autopsy of two men who had died of renal failure.

TABLE I.

	Mgm. per cent.		Mgm. per cent.
Blood	15·4	... ...	14·3
Pleural fluid	16·7	... ...	15·9
Ascitic fluid	18·0	... ...	—
Pericardial fluid ...	—	... ...	14·3
Spinal fluid	2·8	.. ...	2·0
Œdema fluid ...	18·0	... ..	—
Muscle	8·0	... ...	3·9
Heart	10·0	... ...	7·3
Liver	18·0	... ...	15·6
Spleen	12·6	... ...	14·3

Except for the cerebro-spinal fluid and the muscles, the organs contained almost the same amount as the blood. The muscles in one case contained a large amount of uric acid. I therefore calculated the amount which would be present in the body fluids of this patient. Before the cinchophen was given it was 2·11 grm. and on the fourth day it had fallen to 1·36 grm. This was a loss of 0·75 grm. as compared with the 0·84 grm. of "extra" uric acid excreted in the urine. In a second experiment (fig. 3), the "extra" uric acid was 0·63 grm., whereas the apparent loss from the body fluids was 1·0 grm.

It is unreasonable to expect that the figures obtained by these calculations should agree exactly, but they serve to show that the body fluids probably contain sufficient sodium biurate to supply the "extra" uric acid excreted in the urine, after cinchophen.

The uric acid begins to re-accumulate in the blood, and therefore presumably in the tissues, as soon as the cinchophen administration is discontinued. Fine and Chace

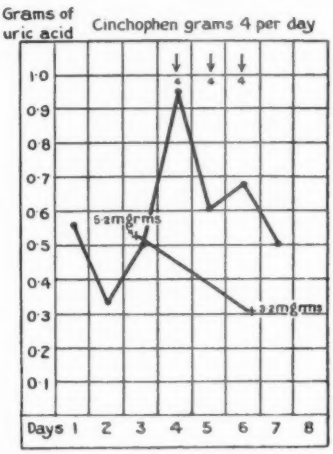


FIG. 3.—The abscissæ represent the days of the experiment. The ordinates represent the grm. of uric acid. The uric acid excreted in the urine is shown by ●, the uric acid in the blood in mgm. per cent. by +. The cinchophen was given at ↓.

[12] found that the uric acid had reached its original level after twenty-four hours. In one of my experiments the blood uric acid had increased from 2 to 4 mgm. per cent. on the third day (fig. 4, page 7). The source of this uric acid is more difficult to be certain about. It cannot be due to a failure of excretion as the amount of uric acid excreted in the urine remained high. It could be due to increased formation, but of this there is no evidence. The other source is the sodium biurate in the bones and elsewhere. In the case of my patient there are ample supplies, and in the course of the six years of treatment I think that the swellings have become definitely smaller, but unfortunately no plaster casts were made. The tophi in the ears and hands have considerably decreased in size and number.

In the light of these observations it would seem that the cinchophen enables the body to rid itself of uric acid and it seems probable that the "extra" uric acid excreted comes at first from the blood and tissue fluids and subsequently from the sodium biurate which has already been deposited. Whatever views may be held about the relation of uric acid to gout, it cannot be good for a patient to store up

uric acid in his body, and on this hypothetical ground alone, I would advocate the giving of cinchophen.

In view of the discovery that cinchophen only caused a large increase of uric acid for the first two or three days of its administration and that it then fell to normal, it was suggested that it was only necessary to give it for three-day periods and then to allow a period in which no drugs are given before beginning another course. I adopted this principle and have treated all my gout cases on these lines :—

The man in question has had cinchophen for the last six and a half years in 20 gr. doses three times a day for three consecutive days in each week. During this period his health has steadily improved, whereas in the previous five years it had become steadily worse. He has only had one attack of gout and on that occasion a mass of sodium biurate, which weighed 35 grm. when wet, was removed by himself from a sinus over the knee. He has never had any massage or radiant heat, both of which are most useful in the treatment of the chronic joint condition, as his hands were too damaged to recover any movement. After some months he said that the state of his knees and ankles was improving and that he was able to walk about much better.

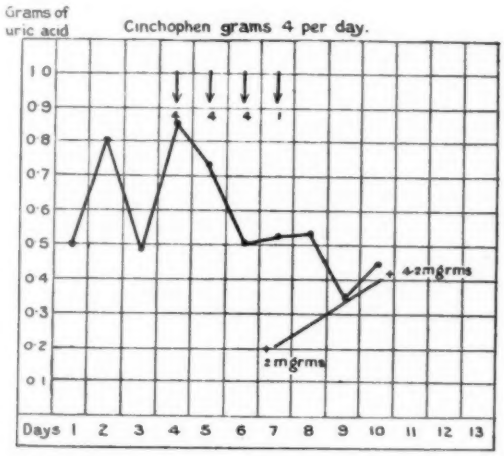


FIG. 4.—The abscissæ represent the days of the experiment. The ordinates represent the grm. of uric acid. The uric acid excreted in the urine is shown by ●, the uric acid in the blood in mg. per cent. by +. The cinchophen was given at ↓.

I have treated many other patients on these lines in the last six years and the great majority have had no acute attacks during this period, and the local condition has improved considerably. One patient, however, had an attack of gout immediately after taking cinchophen on two occasions, and Dr. A. G. Evans has noticed this in one other patient.

Cinchophen is not the only drug which causes an increase in the output of uric acid. Both sodium salicylate and sodium benzoate possess this property. Denis [13] showed that after 100 gr. of sodium salicylate, the excretion was as good as after cinchophen, but a dose of 45 gr. had very little effect. The disadvantage of ordering sodium salicylate for intermittent administration in a dose of 100 gr. a day is that the patient is conscious of its effects, whereas cinchophen causes no symptoms unless it is not tolerated (see later, p. 8).

Cinchophen is also used for other purposes in medicine. It is of use in the treatment of acute rheumatism and relieves the pain just as effectively as sodium salicylate (Hanzlik [14]). It is also used in the treatment of patients with infective arthritis and relieves the pain considerably. It has a considerable effect on the liver and has been used for the treatment of catarrhal jaundice aud the jaundice which occurs in new-born children [15]. Brusch and Horsters [16] have made some interesting observations on a patient with a biliary fistula. They found that cinchophen caused an increase in the volume, in the dry solids, and also in the amount of bile pigment. They investigated various other compounds of a similar nature and found that cinchophen was the only one which had this property although desoxycholic acid acted nearly as well.

Before Nicolaier and Dohrn [6] introduced cinchophen into clinical medicine they had tested its action on animals and had not observed any evil effects. As it has been used more and more, a certain number of unpleasant after-effects have been noticed. Most of these are not serious, e.g., malaise and headache while it is being taken, gastro-intestinal symptoms such as pain and discomfort after meals on those days on which it is taken, urticaria and sometimes albuminuria. No serious complication was described until 1924, when Worster-Drought [17] described a case in which urticaria was followed by a mild attack of jaundice which lasted for some six weeks. In July of 1926, Langdon Brown [18] reported that two patients had developed jaundice and died. Sir William Willcox [19] had also seen three cases of jaundice. One patient who had only taken 15 gr. a day for one week died after being ill for twenty-eight days but the other two patients recovered. C. Wells [20] has recorded the death of a woman who had been taking cinchophen. A. G. Evans [21] reported three cases in which a mild jaundice had occurred, and L. G. Glover [22] described a case in which jaundice had followed the injection of atophanyl, although two previous injections had been given in Germany without any untoward results. With Dr. Langdon Brown's permission I have examined the notes of his two cases :—

Case I.—Patient, a woman, aged 69, suffered from severe pains in the limbs and joints but there was little if any swelling of the joints. The pains were severe and were not relieved by aspirin. Cinchophen was given to her in the Out-patient Department at first for three consecutive days and then when she complained of the return of the pains on the days on which she did not have the drug, it was given continuously. In the course of ten weeks she took 170 gr. a week, in addition to 150 gr. aspirin. At first she was better but after a time she lost her appetite and began to vomit. Later she became jaundiced and was then admitted into hospital. Cinchophen was taken until she was admitted into hospital. She was then very ill, deeply jaundiced. The stools contained some bile and the bilirubin in the blood gave an indirect test by Van den Bergh's reagent. She died on the eighth day after admission. The liver was small. Sir Bernard Spilsbury reported that there was advanced chronic hepatitis, with considerable destruction of the liver tissue. There were large areas in which the liver-tissue had completely disappeared, its place having been taken by fibrous tissue with fibroblasts, and small round cells. The tissue was traversed by bile-ducts in large numbers, a few scattered atrophied cells being present. There were large numbers of liver-cells in all stages of necrosis and disintegration. A few hæmorrhages were present. There was no multilobular cirrhosis and no obstruction in the bile-ducts.

Case II.—Patient, a woman, aged 36, was suffering from a well-marked infective arthritis and was given the allyl ester of cinchophen for a long time in varying doses. She was in hospital for five months and took about 2,000 gr. in the first three months and after a month's intermission she was given a further 330 gr. With one exception the drug was given every day in the week. She developed jaundice, and died some ten days after leaving hospital, and from Dr. N. S. Manning's description the symptoms were very similar to those of the other patient. No autopsy was obtained.

Case III.—C. Wells' patient, a woman, aged 63, had been taking atophan on her own account for a rheumatoid arthritis of some kind. She had about 150 gr. a week, taking some every day. She began to vomit occasionally after about three months but continued to take the drug as it relieved the joint-pains and she did not associate it with the vomiting. She went on taking it until three weeks before she died. Dr. Wells saw her on account of the vomiting some eight days before death. She became jaundiced four days later, and comatose two days later. The liver was very small, and a section by Dr. A. G. Gibson showed a severe chronic hepatitis.

There are four points which seem clear:—(1) It was not the same preparation which caused the symptoms, atophan being responsible for two fatal cases and phenoquin and atoquinol for one case each. In the non-fatal cases different preparations have also been used.

(2) The symptoms followed very different doses. In one case only 60 gr. of agotan were followed by jaundice. In two fatal cases 1,500 and 3,000 gr. had been taken before any symptoms occurred, while in the case of my male patient over 9,000 gr. a year have been taken in 6½ years. The occurrence of symptoms after such various doses can only be explained on the grounds of an idiosyncracy.

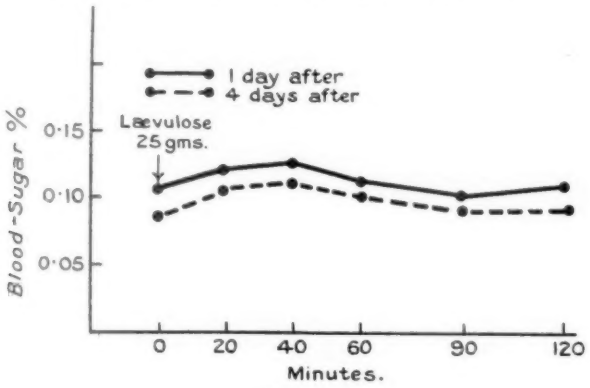


FIG. 5.

(3) In every case but one the drug was given every day of the week without any intermissions.

(4) In some of the patients there were definite signs of disturbance, but these were neglected.

The occurrence of a fatal jaundice following the prolonged use of cinchophen is very disturbing, and I have investigated the state of three patients who have been taking it for some time, namely, the man who has been having it for 6½ years, and two others. Dr. G. C. Linder has kindly made the following estimations for me.

In the case of the man the blood uric acid before the cinchophen was 5 mgm. per cent., and after three days' administration had fallen to 3·6 mgm. It is clear that he still needs cinchophen, and also that it has not lost its effect. The liver function was investigated by means of a dose of 25 grm. lævulose on the first and fourth days after the cinchophen had been stopped. The graph (fig. 5) shows that the two curves are very similar and that the rise in the blood-sugar is only 0·02 per cent., which is therefore quite normal.

Another patient, a woman, aged 55, has been taking cinchophen for nearly four years and has had two slight attacks of gout in this period. The blood uric acid was 2·8 mgm. before

and 1·4 mgm. after the cinchophen. The lævulose test, after 25 grm. (fig. 6), shows that the rise in the blood-sugar was 0·05 per cent. after 60 minims and such a rise is considered to be pathognomonic of liver disease. Three days later, however, the blood-sugar curve appeared quite normal, as the maximum rise which occurred after 40 minims was only 0·02 grm. per cent. Owing to a misunderstanding she had been taking the cinchophen until the last two months every other day instead of having a four days' rest between each course of treatment. It seems probable that this patient investigated has received some slight damage to the liver, but she remains perfectly well (December, 1926). She seems to be having more cinchophen than is necessary, as the blood uric acid is now normal before the course of the cinchophen was given. In the case of a third woman the lævulose curve was quite normal.

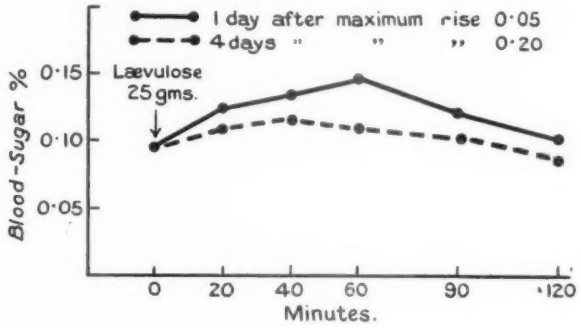


FIG. 6.

What, then, is the lesson to be learnt from the occurrence of these three fatal cases of jaundice? Should cinchophen be abandoned for the treatment of gout? I should be very loth to suggest this as the results are so good in the great majority of cases. I would suggest, however, (1) that its use should be restricted mainly to gout patients. (2) That it should never be given for more than three or four days without giving a four days' rest. (3) That it would be an advantage to control the dosage by means of estimations of the blood uric acid, and if the figure becomes normal the dose can be reduced to two days a week, or even one day a week.

This completes my short survey of the treatment of gout, and in conclusion I would emphasize the importance of bearing in mind the possibility of any joint lesion being due to gout, because this is one of the few types of chronic arthritis which yield to treatment.

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Section of Tropical Diseases and Parasitology.

President—Dr. R. T. Leiper, F.R.S.

The Relative Numbers of Male and Female Gametocytes in Human Malaria (*Plasmodium vivax*, *Plasmodium falciparum* and *Plasmodium malariæ*) and *Hæmoproteus* in Birds.

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Numerous factors, many of them unknown, influence the epidemiology of malaria in different countries, or even in very circumscribed areas of certain regions, and, while it is usually easy to elucidate most of these problems, many remain obscure. Certain species of parasites predominate throughout the year in some countries, whereas, in other countries, there is a definite seasonal alteration in the species found.

Although temperature, humidity, species of anopheline, etc., are all important in the transmission of malaria there are certain obscure factors influencing the development, survival, and final infection of certain anophelines.

Stephens and Christophers (1902) and Bentley (1911), in India, have noted that *Anopheles rossi* seldom, if ever, acts as a transmitting agent. Again, in experimental infection of anophelines well known as carriers of malaria, varying results may be obtained by feeding on a case with gametocytes circulating in the blood. For example, Mitzmain (1916) fed a batch of 219 specimens of *Anopheles punctipennis* on a crescent case and obtained no infection. Later, however, he repeated the experiment, feeding the same species on another case, and obtained 27 per cent. of infected mosquitoes. One important factor influencing the infection of the mosquito is possibly the relative proportion of male and female gametocytes in the peripheral circulation at the actual time of feeding. Whilst it is generally recognized from a casual examination of a blood-film that female gametocytes seem to preponderate over the males, it will be noted from the accompanying tables that only a few observations of an accurate nature have been made, and, further, that there are considerable variations in the results recorded. The observations reported here were carried out in order to obtain additional information regarding the relative proportions of sexes in all three species of human malaria, and, further, to compare them with *Hæmoproteus* in birds. Most information regarding the relative proportion of sexes among the gametocytes is based on the examination of crescents, and the literature contains scant information regarding *Plasmodium vivax* and *Plasmodium malariæ*.

Previous Observations on the Relative Numbers of Male and Female Gametocytes (found) in Human Malaria.

It appears that Christophers and Stephens (1900), in their work on the Malarial Commission of the Royal Society, were the first to attempt a study of the relative numbers of male and female gametocytes, and, curiously enough, they reported a preponderance of males over females. As will be noted below, this is contrary to later observations of a more extensive character.

Recently, Knowles (1919), in daily examinations of the blood of a case of subtertian malaria under treatment, found a marked increase of female over male gametocytes, namely 10 to 1, and, as this table is composed of continuous daily counts, it is appended for reasons of comparison.

TABLE I.—KNOWLES.

Date	Total number of crescents	Macrogametocytes	Microgametocytes
November 25, 1917	27	23	4
November 27, 1917	56	49	7
November 28, 1917	29	25	4
November 29, 1917	19	18	1
November 30, 1917	45	41	4
December 1, 1917	31	29	2
December 2, 1917	26	25	1
December 3, 1917	3	3	0
December 7, 1917	16	15	1
December 11, 1917	14	14	0
December 12, 1917	4	4	0
December 13, 1917	9	8	1

From the above table it will be noted that the number of crescents counted was not at any time very large, and, further, that they were diminishing in numbers, probably owing to the action of quinine. With the diminution in numbers the males seemed to disappear more rapidly than the females. This same rapid reduction of the males is also manifest in the counts of Abrami and Sénevet (1920), who conducted daily observations over a considerable period. The counts of the latter observers were more comprehensive in that they examined a very much larger number of gametocytes, and thus the results are probably more accurate.

TABLE II.—ABRAMI AND SÉNEVET.

Date	Total number of crescents counted	Females per cent.	Males per cent.
	Section I.		
October 25, 1920	1,500	52	44
October 26, 1920	1,500	47	31
October 27, 1920	1,500	41	53
October 28, 1920	1,000	52	44
October 31, 1920	400	45	47
November 1, 1920	200	56	38
November 2, 1920	83	55	38
November 3, 1920	85	62	30
	Section II.		
	175	59	29
	1,015	56	41
	400	71	23
	200	76	19

It is interesting to note that on two successive days there was a preponderance of male over female gametocytes, and, further, that at first the percentages of males and females very closely approximated to each other. Towards the end, however, the percentages of males seemed to decrease progressively. In Section II of the table four different counts are given from four different cases, from which it can be seen that in every case the females predominated.

Stephens and Gordon (1924) recorded counts from blood-films taken daily of a case of *Plasmodium falciparum*.

TABLE III.—STEPHENS AND GORDON.

Date	Observer A. Percentage of		Observer B. Percentage of	
	Females	Males	Females	Males
August 5, 1923	72	28	26	24
August 6, 1923 [1]	70	30	85	15
8 a.m.				
August 6, 1923 [1]	73	27	88	12
3 p.m.	75	25	—	—
August 7, 1923 [1]	72	28	76	24
August 8, 1923 [1]	67	33	78	22
August 9, 1923 [1]	66	34	76	24
3 p.m.	68	32	—	—
August 10, 1923 [1]	68	32	78	22
August 12, 1923 [1]	72	28	82	18
August 14, 1923 [1]	66	34	74	26
Average	70	30	80	20

[1] Quinine hydrochloride, grains 20.

In order to eliminate as far as possible the personal error, these workers did independent counts, and, where possible, they counted at least 500 crescents. These latter tables, therefore, are of intrinsic value, in that they were carefully controlled. The combined count given by these observers supplied a ratio of three to one in favour of female crescents.

Observations on the Present Cases.

The blood-films chosen for the present communication were obtained from different parts of the world without any knowledge of the history or stage of the disease. They contained gametocytes of *Plasmodium falciparum*, *Plasmodium vivax*, and *Plasmodium malariæ*. Careful differential counts were made in each case of the relative numbers present. The points usually noticed in differentiating the sexes are added for the sake of comparing this particular work with the observations of other workers. In the macrogametocyte the chromatin is compactly arranged, and the pigment assembled in a mass consisting of deeply stained spicules. The cytoplasm stains intensely and of a dark-blue colour. In the microgametocyte, the chromatin is scattered more diffusely, and the pigment dispersed in fine granules. The cytoplasm stains lightly, and may have a mauve tinge. The differentiation of sexes is more or less a simple matter in *Plasmodium falciparum*, provided the film is well stained to show the chromatin; there are, on the other hand, considerable difficulties in the case of many films in differentiating the sex of *Plasmodium vivax* and *Plasmodium malariæ*. In quartan malaria, infections, as a rule, are small in the peripheral blood, and it is not easy to find films which contain sufficient gametocytes on which to base satisfactory counts. Further, owing to the delay in schizogony, it is only possible to estimate the sex with certainty when the gametocytes are fully developed.

As regards the actual numbers of sexual forms circulating in the peripheral blood it will be seen from the tables that the gametocytes of malignant tertian far surpass in numbers those occurring in benign tertian and quartan. In subtertian as well as in other species, immature gametocytes are encountered, and in these forms it is difficult or impossible to assign definite sex. Such forms, for example, may appear in large numbers in the circulation of pernicious malarial cases with coma.

In studying these tables individually it will be noticed that, in the case of *Plasmodium falciparum*, a ratio of about three to one was obtained in each instance.

Table IV.—Malignant Tertian.

Blood-film	Male	Female
1	156	485
2	193	631
3	127	493
4	143	428
5	129	386
6	6	22
7	146	535
8	16	95
9	23	61
10	114	372
11	32	83

In two films, Nos. 7 and 8, however, a ratio of four to one, and six to one respectively was obtained. This corresponds with the results obtained by Stephens and Gordon in their counts. The films vary considerably in their content of gametocytes. A factor influencing this is possibly the varying quantity of gametocytes daily poured into the peripheral blood. Thomson (1911), while working with *Plasmodium falciparum*, arrived at the following conclusions:—

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"(*a*) Crescents do not generally live more than a few days in the peripheral blood. (*b*) Fresh broods of crescents come into the circulating blood daily or every other day, or irregularly, according as the temperature is quotidian, tertian or irregular."

S. P. James (1926), while working with *Plasmodium vivax*, found differences in the numbers of gametocytes in the peripheral blood, and considerable differences in the number present in the blood of the same patient from day to day. He reports that there were fewer males than females. In *Plasmodium malariæ* the female gametocyte predominates and the male is rarely seen; thus, from the table below, a ratio of four to one is obtained.

TABLE V.—QUARTAN.

Blood-film	Male	Female
1	7	27
2	5	13
3	11	48
4	7	29
5	9	33
6	16	69

This is in accordance with the finding of W. M. James (1910), who, working in Panama with quartan, observed that the parasites in the peripheral blood were scarce, and that the male gametocytes were rarely seen. In *Plasmodium vivax* great difficulty was experienced in determining the sex, although the gametocytes were present in abundance on the slides chosen.

TABLE VI.—BENIGN TERTIAN.

Blood-film	Male	Female
1	24	62
2	37	114
3	24	27
4	21	79
5	37	85
6	29	70

As will be seen from this table, the females preponderated, and a ratio of about three to one was obtained. S. P. James (1926) in three instances records that out of an average of 100 counted (1) thirty-five were male and sixty-five female, (2) twenty-three were males and seventy-seven females, and (3) forty-three were males and fifty-seven females.

A series of daily blood-films of *Hæmoproteus* obtained from a Java sparrow are appended for comparison with the counts obtained in human malaria.

TABLE VI.—HÆMOPROTEUS.

Date	Male	Female
October 6, 1926	41	69
October 7, 1926	82	132
October 8, 1926	93	121
October 11, 1926	67	129
October 12, 1926	45	70
October 13, 1926	43	71
October 14, 1926	47	81
October 15, 1926	55	101
October 18, 1926	61	97
October 19, 1926	74	85
October 20, 1926	97	115
October 21, 1926	79	107

The proportion of male to female elements approximated each other much more closely than in the case of malaria, in fact, the ratio was about 1-1 to 1-1·5.

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DISCUSSION.

An examination and comparison of the different observations given in all these tables emphasize the fact that, at certain periods in the disease, the incidence of gametocytes in the peripheral blood varies from day to day, and the percentages of the sexes also vary. This variation may result from a natural attempt to establish a correct balance in the numbers of male and female elements circulating in the peripheral blood, thus ensuring propagation of the species. Examples may be cited. In the hæmogregarines, the gametocytes come into apposition with each other before copulation, and only one or two microgametes are formed. In the *Eimeria* group of the Coccidia, which occur in the intestine of various animals, the gametocytes are often separated very considerably, and, in order to increase the chances of fertilization, innumerable microgametes are produced. In *Hæmoproteus*, and in the various species of human malaria where the gametocytes remain apart in a confined area, viz., the stomach of the transmitting insect, the relative number of males and females approximate more closely to one another. The male, although actually less numerous than the female (as seen in the above tables), produces four, five or more microgametes, thus establishing favourable chances for fertilization. In the case of human malaria, it is only when the correct proportion of male and female gametocytes circulating in the peripheral blood is attained that the most favourable conditions are present in order to enable the parasite to complete its life history. These observations supply one of the factors necessary for the successful infection of mosquitoes, whether under natural or experimental conditions.

My thanks are due to Dr. J. G. Thomson for encouragement, advice and criticism.

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Dr. P. MANSON-BAHR pointed out that sporozoal parasites were not alone peculiar in the preponderance of the female forms; the same thing was seen in higher branches of the animal kingdom, including man himself, though amongst the unisexual trematodes Fairley had recently demonstrated that the males outnumbered the females. Fairley had also shown that it was the female which was specially affected by parasiticidal drugs. Was this so in the case of *Proteosoma hæmoproteus* and the malaria parasite? It would be a most interesting point to determine, and it was one that Mr. Annecke might well undertake. He (the speaker) had been very puzzled by the remarkable action of the new antimalarial drug—plasmochuin—upon the gametocytes of malaria, especially those of *Plasmodium falciparum*; these disappeared within three to four days after its administration, which was certainly not the case in quinine therapy. If it was a fact, as Dr. Gordon Thomson had suggested in 1911, that the gametocytes were but short lived and were shed into the circulation in swarms at periodic intervals, then the rapid action of the drugs upon the young trophozoites would readily explain the apparent rapid destruction of the gametocytes. This significant piece of research could be equally well carried out in proteosoma infection of canaries as in malaria infection of man.

Some Modern Biological Conceptions of Hydatid.

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Among the many parasites which infest man, none is more serious than the larval stage of tapeworm of the genus *Echinococcus*, which is generally referred to, in this country at least, as hydatid.

The members of the genus *Echinococcus* are small but typical tænias, in which only one or two immature segments, one mature segment, and one gravid segment as a rule are found. Formerly it was believed that only one species of this genus existed—*Tænia echinococcus* or *Echinococcus granulosus*, as it now is more generally called. In 1863, however, Diesing described, from a jaguar, another tænia, which undoubtedly is closely related to it and which the present writer has now placed in that genus under the name of *Echinococcus oligarthrus*. He has found it in *Felis yaguarundi*, another species of South American cat. At the same time he has described two other forms which he considers are new species—one, *Echinococcus minimus* from *Canis lupus* from Macedonia, and the other, *Echinococcus longimanubrius* from *Lycaon capensis* from South Africa.

It is improbable that this exhausts the number of species in the genus, and there is little doubt that other members will ultimately be described.

Hosts.

The definitive hosts of the genus *Echinococcus* are various members of the carnivores. The most important host of *Echinococcus granulosus* is the dog, but the fox in this country has been found on several occasions to be harbouring the parasite. The wolf, jackal, coyote, dingo, and other Canidæ elsewhere, have also been found infected naturally. Felidæ are only infected with difficulty, and probably play little part in its dissemination. On the other hand, *Echinococcus oligarthrus* has only been found on two occasions, and then in cats.

The intermediate hosts include almost all the mammals. The optimum host seems to be the sheep, but pigs, horses, camels, cattle, and goats, are also infected among the domestic mammals, and hydatid cysts are frequently found in wild mammals. Man is often infected—especially in pastoral countries,—but he must be considered as an accidental host, because the parasite is never likely to fulfil its normal life-cycle in human beings.

So far no cystic stages have been definitely linked up with the other species, but it is almost certain that the hydatid stage of an echinococcus, which was described by Brumpt and Joyeux, in 1924, as *Echinococcus cruzi*, from the agouti from Brazil, is the larval form of *Echinococcus oligarthrus*. This differs only in slight details from the typical hydatid. How much of the South American disease is due to this species is not known, but its re-discovery opens up questions of the highest scientific interest. The description of two apparently new forms also opens up the important question of the quality or otherwise of the various forms of cysts which have been found in human beings and in animals, and so serves to draw attention to the vitally important work which has been carried out within the last few years on the biology and life-history of the parasite. This is the more important, as with few exceptions the text-book descriptions are wrong. This work has been done by several workers, but most prominent among them are Professor F. Dévé, of Rouen, and Dr. Harold Dew, of Sydney. The enormous literature which has accumulated

round the subject recently has prevented the real importance of these workers' discoveries being generally understood, and my function in this paper is largely that of an expositor.

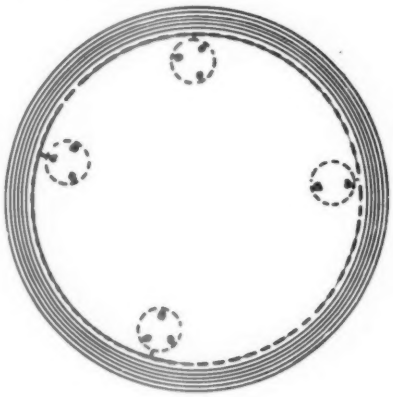


FIG. 1.

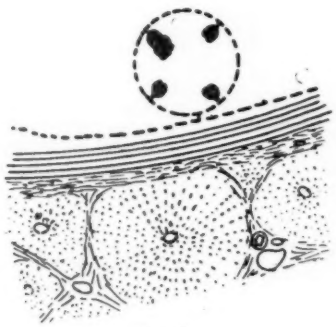


FIG. 2.

FIG. 1.—Structure of a hydatid cyst. The cuticular layer (continuous lines) surrounds the germinal layer (dotted lines) which gives rise to it and to the brood capsules.
FIG. 2.—Histology of a hydatid cyst. From top to bottom, the following structures are seen: Brood capsule with scolices, germinal layer, cuticle, adventitious cyst, liver.

THE HYDATID.

In its normal aspect the hydatid is a spherical vesicle completely filled with a transparent fluid. The wall of this vesicle is thick and white and consists of two layers; an *outer*, thick, concentrically laminated, amorphous and refringent, called the *cuticle* or laminated membrane; and an *inner* consisting of a thin plasmodial membrane, nucleated and containing glycogen granules, called the *germinal* layer. On this germinal layer are found innumerable minute *brood capsules*, easily detached and often found lying free in the fluid, when they are called "hydatid sand." These capsules contain several scolices with four suckers and two rows of thirty-two to thirty-eight hooks. In its early stages these capsules are absent, when the vesicle is termed "acephalocystic"; but as a rule, by the time the cyst has reached the size of an apple it contains brood capsules. It sometimes, however, remains sterile throughout its life.

This is the normal structure of the hydatid vesicle. It is surrounded by an adventitious cyst formed by the host.

THE CYST.

It is the general custom to speak of the hydatid vesicle as the "cyst" and the fibrous envelope as the "pericystic membrane." The name "cyst," however, ought to be reserved for the fibrous envelope which "encysts" the parasitic foreign body. This envelope is not an independent membrane, but is continued without any definite line of demarcation into the host substance. It is never adherent to the parasite itself. This adventitious capsule is formed by a local atrophy of the host substance, caused by the distension of the growing wall. Under the influence of this pressure, combined with the local toxic action, the parenchyma is destroyed and a fibrous tissue comes to replace it. This tissue is essentially avascular, and such blood-vessels as it contains are merely accidental; on the other hand, mucous canals (bile-ducts, bronchioles, etc.), which become involved in the cyst show no tendency to be

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obliterated, although they may become flattened. This explains the frequency of their opening into the cystic cavity and of the elimination of the hydatid debris into the bronchi, bile-ducts, and so forth.

The fact that hydatids do not become adherent to the cyst wall explains the frequent rupture of the cyst into the serous cavities.

Life History.

The Development of the Hydatid Vesicle.

The "egg," as found in the stool of the dog, resembles very closely the eggs of the various species of *Tænia*. It is really an "onchosphere," the true shell having been dissolved off in the intestine. It consists of a thick chitinous shell, with radial striations, in which lies a more or less spherical hexacanth larva which possesses, as its name implies, the six hooklets characteristic of all cestodes. These "eggs" are remarkably resistant to all normal conditions; they can withstand twelve days' drying, seven days in water and four months in ice.

This "egg" is swallowed as a contamination, and in the stomach the "shell" is digested away and the embryo escapes. By means of its hooklets, the embryo moves actively into the thickness of the digestive mucosa until it enters a blood-vessel, when it is carried passively by the blood until held up by the narrowing capillaries. The hooklets are probably shed immediately after it passes through the wall. This filtering action of the capillaries explains the extreme frequency of the hydatid in the liver and lungs. The most frequent site of the implantation is the substance of a liver lobule, about a third of the way towards the centre from the periphery. If the parasite passes the "hepatic filter" it enters the inferior vena cava and is carried to the lungs. Once it has reached its site of development—which it can do within three hours of being swallowed—it is rapidly attacked by mononuclear leucocytes and, on section, is not visible in the midst of this attacking host. By the sixteenth hour it has reached the diameter of 20 microns, and is recognizable as a small, roundish, nucleated mass lying in the midst of an inflammatory nodule, ten times its diameter. By the fourth day, the parasite has become 40 microns in diameter and is commencing vacuolation, and at the end of the first or second week it is definitely a hydatid, although only 60 to 70 microns in diameter. The germinal layer can be recognized, with its granular nucleated protoplasm, and surrounding it is a thin hyaline cuticle.

By the end of three weeks the follicle is about $\frac{1}{4}$ mm. in diameter, and is now vacuolated. Definite changes have occurred in the surrounding host-cells. Adjacent to the parasite the endothelial cells are arranged radially, and many giant cells are present as well as infiltrated eosinophils. Just outside this is a zone of fibroblastic mononuclear and eosinophil cells as well as of new blood-vessels, although the vascular reaction is now no longer intense. Beyond this zone the fibrous cells shade off into liver-cells, some of which are undergoing pressure atrophy. As the parasite increases in size, this adventitia becomes more clearly differentiated into layers, and the outer layer becomes more definitely fibrous. At the same time the hydatid grows steadily, producing its specific fluid and assuming a more or less spherical shape.

By the time it is three months old, the parasite has reached the size of 40 to 50 mm. in diameter. The nuclear material has developed an elastic, cuticular, laminated membrane. The germinal layer is heavily nucleated, but as yet there is no development of brood capsules. The adventitia consists of a layer of radially arranged endothelial and giant cells—much narrower relatively than in younger stages. Eosinophils are still present in numbers. Outside this layer are the concentrically

arranged fibroblasts, which shade into a zone of atrophying, compressed liver cells. Eosinophils are not common here, and the liver is settling down to keeping the organization of the adventitia in pace with the growth of the hydatid.

At five months the cyst is about a centimetre in diameter. Pouching may be seen—often giving a multilocular appearance to the cyst—owing to the resistance of the bile-ducts to fibrosis. This resistance probably also explains the frequent entry of the bile into the cyst at later stages.

The laminated membrane is thicker and is being continually laid down from inside. The adventitia is thickened and appears white and fibrous. The endothelial layer is still present but becomes flattened out, necrosed and converted into fibrous tissue. The fibrous tissue at the periphery blends with the surrounding liver tissue. Brood capsules are still absent. In the pig, in which most of the experimental work has been done, the fibrous nature of the liver causes considerable pouching owing to

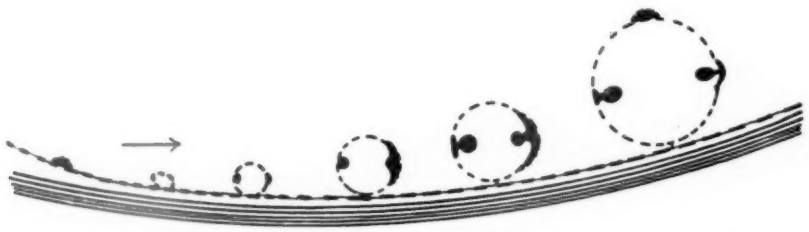


FIG. 3.—The evolution of the brood capsules. (The adventitious cyst is not shown in this diagram.)



FIG. 4.—The evolution of the scolices. The brood capsule is represented for the sake of clearness as a straight line instead of a circle.

mechanical resistance to the growth of the parasite, and multilocular cysts are produced. Retrogression is not uncommon at this stage owing to invasion of the laminated membrane by eosinophil cells and giant cells.

Development of Brood Capsules and Scolices.

The brood capsules appear as multiplications of one of the small nuclear masses of the germinal layer. This mass grows, becomes vacuolated and forms a small vesicle, ultimately becoming pedunculated, remaining attached to the parenchyma by a small delicate pedicle which is very easily broken by trauma. The brood capsules are not developed evenly throughout the wall but tend to aggregate in spots. These brood capsules are not divided into two layers as is so often stated.

Inside the brood capsules, the scolices develop as a local thickening, which rapidly becomes a small bud, on the inner surface of which cuticular material is laid down. The wall tends to evaginate and the papilla continues to develop in this evagination. The head increases in size and is soon forced into the cavity of the brood capsule, where it develops its typical shape, becomes pedunculated and suckers appear. The

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cuticular material spreads down the stalk and at the other extremity develops into hooklets. This growth progresses until the mature scolex is formed, swinging on its stalk in the brood capsule. It has, however, acquired the faculty of withdrawing its head inside its body in order to protect the important hooks from damage by adjacent scolices. And in this resting position, with the hooklets reversed, it remains until swallowed.

Variations of this development, due to circumstances and to the muscular development of the scolex are seen. In the first few scolices in each brood capsule, cupping is slight or absent, and it is only when crowding occurs that scolices, up to forty in number, may be visible in a single capsule.

Each scolex has a cuticular covering which spreads on to its stalk but does not cover the inner surface of the capsule. This layer is never complete, and it is only seen in old capsules, but it is responsible for the common notion of the "reversal" of the layers in the brood capsule.

External budding is also never seen and the so-called cases of external development of scolices are due to the rupture of the brood capsule which is elastic, tends to turn inside out and so simulates this "external" budding of the text-books.

It is not yet known whether solitary scolices may develop directly on the germinal layer and without the intervention of brood capsules. Many of the cases observed are apparently due to this rupture and inversion of the brood capsule but it is not impossible that solitary scolices may be able to develop direct. It must, however, be regarded as an exceptional method.

Daughter Cyst formation is *not* a normal part of the parasitic life cycle. It is only when the continued existence of the hydatid is threatened that daughter cysts are produced. Amongst other causes, this may be due to mechanical trauma (including puncturing with a trocar), chemical trauma (bile or urine) or bacterial trauma. Age also plays a part, and in children, daughter cysts are seldom found. Thus daughter cysts in the liver (the commonest site) are usually bile-stained; in the kidney they are contaminated with urine and so forth. Daughter cysts are invariably found in subcutaneous, muscular or heart cysts. Owing to some accident, all or part of the germinal layer comes to lie free in the cavity of the cyst. It is unable to proceed with its normal development without cuticle, so it forms new cuticle round itself, and inside this the cysts develop. Lowering of the intercystic tension has a similar effect. Exactly how age causes the production of daughter cysts is not known, but it is probably due to lack of nourishment owing to the thickness of the adventitia.

In young children (before puberty) not more than 10 per cent. of hydatids have daughter cysts, while the same is true for animals, daughter cysts only being found in old animals.

Omental Cysts.

Omental cysts are usually secondary or heterotrophic. Heterotrophic cysts are merely those which have slipped out of their adventitia in the liver or elsewhere, and, having dropped into the serous cavity without rupture, have continued to develop there. (This is common in the case of *Cysticercus tenuicauda* in sheep and pigs.)

Secondary cysts are commoner and are due to a rupture of a primary liver (or other) cyst and the formation of cysts from the fragments of germinal layer, scolex or brood capsule: a new adventitia may be formed from the omentum. All have a precarious blood-supply and consequently there is a poor production of brood capsules and scolices. Degeneration is common and with it there is an entry of serum, &c. This either destroys the cysts or causes the production of daughter cysts. This is one reason for the multiplicity of omental cysts; other reasons will be stated later.

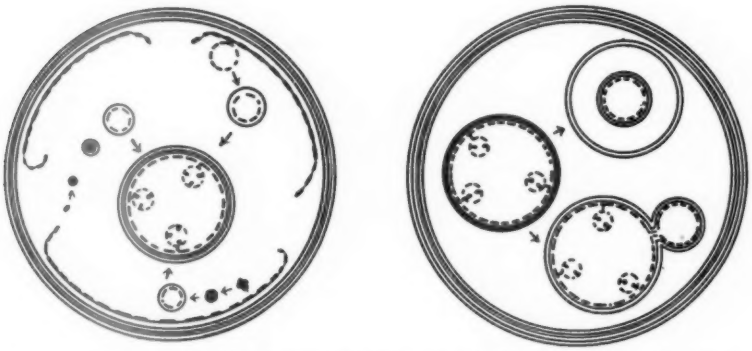


FIG. 5.—The formation of daughter cysts (left) from germinal layer, brood capsule or scolex; and the formation of granddaughter cysts (right) by endogenous or exogenous methods.

MECHANISM.

Daughter cysts may be formed in one of three ways.

(*A*) *From the Original Germinal Cells.*—This idea was first mentioned by Naunyn in 1862, but he considered that they were formed by partial collapse of the membrane with adhesions between adjacent portions, new cysts thus being originated. Dévé, however, showed (and Dew has since confirmed this fact) that the germinal wall may give rise to daughter cysts under a method analogous to that by means of which brood capsules are formed, an external laminated membrane being laid down instead of internal scolices being formed. These daughter cysts may, in a similar manner, form granddaughter cysts. The germinal layer becomes detached from its cuticle and floats freely in the centre of the cavity. It is unable in this position to develop normally, and islets of germinal layer deposit fresh cuticular material as a protection, and thus the daughter cysts originate. Brood capsules are found in these daughter cysts at an extremely early age, when the parasite is only 1 to 4 mm. in diameter. This modern view differs from Naunyn's conception in that it is due to the active processes of the parasite, not to the passive pouching or sacculation and fusion of contiguous layers. Dew considers this to be the most common method, although Dévé regards it as rare.

(*B*) *From Brood Capsules.*—The cells of the germinal layer of the brood capsules are arranged in a single layer and they have the same power of producing cuticle as is possessed by the original germinal layer—although normally the germinal layer does not produce it. Both Dew and Dévé have attempted to prove that it does, but it is difficult to exclude cyst formation by the contained scolices. One of Dew's experiments strongly suggested that this method was sometimes followed—the scolices degenerating as cuticular material was laid down; whilst one of Dévé's experiments suggested that the scolices formed granddaughter cysts inside a daughter cyst formed from the brood capsule. It cannot yet be accepted as absolutely definitely proved that this does occur. There is no reason why it should not, however, and Dew considers that it is a relatively common method.

(*C*) *From Scolices.*—The scolex is a highly specialized form with suckers, hooklets, cuticle, &c. Normally, it remains quiescent until swallowed by the definitive host, but vesicular changes were described by Naunyn in 1862, and, later, both Dévé and Dew, by means of experiments on rabbits, have definitely proved that scolices may give rise to cysts. Scolices, carefully separated from brood capsules,

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have been injected subcutaneously, intravenously, intraperitoneally, and intramuscularly, and cysts have been found in various situations after these injections. The scolex increases in volume, cells separate, muscles become peripherally arranged and the cuticle thickens. Ultimately the whole becomes vesiculated, the hooks and other structures disappear and a daughter cyst results. Dévé was able to show, moreover, that hydatid embolism could exist and secondary cysts could be formed in this way. However, the majority of scolices which escape by way of the blood-vessels are disintegrated or enclosed by fibrous tissue and only a small proportion develop.

Dew considers that this method is uncommon *inside* the mother cyst, occurring, when it does, from relatively undifferentiated scolices, but that implantations of scolices, *outside* the original cyst, readily occur under sterile conditions with secondary cyst formation.

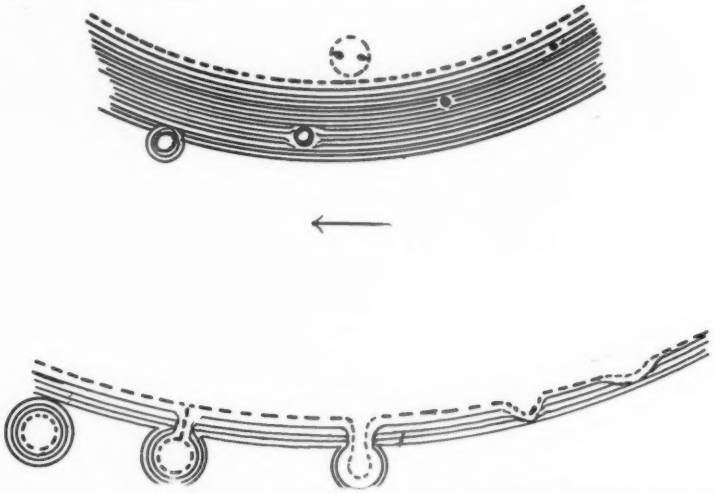


FIG. 6.—Diagrams showing the methods of "exogenous" daughter cyst formation. The upper diagram illustrates the classical belief; the lower the modern belief as expressed by Dew.

Endogenous daughter cyst formation by small-cell islets in the laminated cuticle travelling *inwards*, *never* occurs, although great prominence is assigned to this method in many text-books.

EXOGENOUS CYSTS.

The "classical" view of the formation of the so-called exogenous cysts is that a small piece of germinal layer is included in the cuticular layer and that it gradually passes by exfoliation of this layer to the exterior, where it becomes detached and forms an exogenous cyst. Dévé considers that this method is followed, but Dew suggests a slightly different explanation. Exogenous cysts are practically confined to hydatid of bone and omentum of man, and to herbivora. Dew considers that in these cases the so-called exogenous budding is merely external herniation of *both* layers through relatively weak parts of the adventitia, the herniations being finally extruded with the formation of small detached cysts.

(*A*) *Omental Cysts.*—Secondary omental cysts are always the result of implantation of scolices or brood capsules following a leakage or rupture from a primary abdominal

cyst. The adventitia is formed from the omentum or subperitoneal tissue and in consequence is very variable in thickness, sclerotic areas alternating with transparent thin areas with little external supporting tissue. This is a situation in which multiple cysts are common.

(*B*) *Recurrent Cysts.*—Recurrent cysts in scar tissue are cysts which occur in a common adventitia and have generally been considered as examples of exogenous budding, but Dew considers that this is not the correct explanation. These cysts as a rule are produced by cystic development in brood capsules and scolices implanted in operation wounds and are strictly comparable with omental cysts Dew believes that the explanation in both cases is that these cysts arise from several contiguous scolices. The rate of growth of cysts is very variable under identical conditions. If one gets ahead for some reason or another it will rapidly grow, its surface area compared with that of the others increasing in the ratio of the cube of the radii, and so giving the ultimate appearance of mother and exogenous daughter cysts. A similar explanation probably also accounts for similar subcutaneous or muscular cysts. The small mother cyst is ruptured by injury, and fragments may be carried even some distance when daughter cysts are formed. In larger cysts, however, Dew considers that herniation is the commonest factor involved. By constriction of the neck of the pouch and fusion of the germinal layers a cyst is formed which begins to lay down cuticle and gradually separates. It may even acquire an adventitia of its own. The process, at first passive, due to intercystic pressure, becomes active when once started.

(*C*) *Osseous Hydatid.*—When the young hydatid comes to rest in the bone it attempts to form a spherical vesicle, but cannot do so owing to the dense surrounding tissue. Accordingly, the parasite spreads along the bony canals, which are the lines of least resistance. The rate of growth is slow and the final picture is one of gelatinous infiltration of the bone. When an open space is reached, a small cyst forms, measuring a few millimetres in diameter. It has no regular adventitia and the parasite lies in actual contact with the bone in some places and tends to erode it. In other places there is a definite tissue reaction and giant cells are seen. There is little fluid, and cuticle is irregular and generally excessive. There is no scolex production, as a rule, in the bone, but if the parasite reaches the surface it may be fertile and usually assumes its normal spheroidal shape. Degeneration areas are common, with phagocytic giant cells. Ultimately the bone becomes so weakened that spontaneous fracture is common. The appearance of exogenous cysts is due to herniations in the bony canal, which become cut off and the "necks" removed by phagocytosis. No true mother cyst exists. In the normal cysts which reach the surface endogenous daughter cysts are sometimes found, but no exogenous cysts have ever been seen.

(*D*) *Granddaughter Cysts.*—Granddaughter cysts may be, and generally are, formed in exactly the same way as endogenous daughter cysts, but they are sometimes formed by herniation through the thin cuticle of the daughter cysts. The neck becomes constricted off and the granddaughter cyst may remain adherent to the daughter cyst. Great-, or even great-great-granddaughter cysts may be thus formed.

Abnormal Forms of Hydatid.

In sheep the following variations of hydatid are found.

(*A*) *Simple univesicular cysts* are much the commonest and are identical with the unilocular human cyst except that, even in old sheep, they are rarely over 10 cm. in diameter. It often happens that a certain degree of pouching is seen, due to the cyst meeting obstacles to its growth and proceeding along the line of least resistance. Daughter cyst formation is very rare.

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(*B*) *Multilocular cysts* are sometimes found—especially in lungs—with loculi of varying size separated by incomplete septa and communicating with a common cavity. The structure is typical and the hydatids are usually fertile. This shape is probably due to the dense fibrous wall formed by the sheep preventing the normal symmetrical development. Owing, also, to this dense membrane, the passage of food is inhibited and degenerate cysts are common. It is caused by extension of the cyst along the lines of least resistance, with the ultimate formation of secondary cysts.

(*C*) *Multicystic cysts* are rare and take the form of congeries of small cysts embedded in a dense fibrous stroma. They occur in liver or lung—often in association with simple cysts—are uniform in size, have well developed cuticular coats, but small quantities of fluid, and are invariably sterile. Involution is common. The wall consists of avascular, poorly organized, fibrous tissue with a honeycomb appearance. The adventitia is hyaline and calcification is common. Sometimes in this form a cellular reaction is seen, such as is observed in the ox. Dévé considers that this develops by exogenous budding, but Dew thinks it is analogous to human osseous hydatid. The lesion, as in the ox, is local and circumscribed.

(*D*) A final type of hydatid has been described from sheep by Dévé. It is about the size of a pigeon's egg, and resembles a solid mass of a more or less opaque colloid appearance. It consists of shrunken germinal membrane, variously folded and showing a sort of cuticular hyperplasia. The cyst is in process of involution, and degenerative scolices are often found in the folded depressions of the primitive cavity. The adventitia suffers from a circumscribed necrosis. This type is obviously pathological (from the parasitic point of view) and in process of degeneration; it need not, therefore, be considered further.

In the ox two forms of hydatid are usually found:—

(*A*) *Simple cysts* are generally seen in the lungs and are usually sterile, while multilocular cysts of the bovine type are also seen in the liver. Both have poorly developed cuticle and are usually degenerate.

(*B*) *Bovine multilocular hydatid* is the typical form found in the ox. It consists of a mass of small cysts—up to 1 cm. in diameter—separated from each other by fibrous septa. The parasites are invariably sterile, commonly degenerate, and have poorly developed laminated layers. The cyst wall is well developed and there is usually a sharp line of demarcation between it and the surrounding tissue. Necrosis and calcification may be seen. The greater part of the lesion consists of adventitious tissue—dense, fibrous trabeculæ enclosing irregular spaces containing shrunken, laminated membrane and caseous debris. The cellular reaction of the host is very characteristic and different from that observed in sheep and human beings. It may be divided into three zones:—(*a*) An inner layer of columnar, radially arranged endothelial cells, with the nucleus at the peripheral end, and often with giant cells present. (*b*) A middle layer of round cells—eosinophils and young connective tissue cells; red blood-cells are also present. (*c*) An outer layer of concentrically arranged connective tissue cells (often containing chalk granules) merging into the host stroma, which passes from a more or less atrophied, compressed condition to normal. The laminated membrane is thin, but often contains a little fluid.

The tissue of the ox, of course, reacts very strongly to such agents as tuberculosis, actinomycosis, etc., and forms well developed gross lesions, characterized by dense early fibrotic and calcareous changes.

In the other domestic animals, hydatid has not been so extensively studied.

In the pig, hydatid of the liver is commoner than hydatid of the lungs (the reverse is the case with cattle and sheep), and it tends to form either a simple cyst or one showing some degree of sacculation. The bovine multilocular form is rare; but the human alveolar form—or a form similar to it—has occasionally been observed in Germany.

In the horse, the simple form in the liver is the commonest form—in Britain at least—and multilocular and multicystic forms are rare.

Alveolar Hydatid in Man.

In 1855, Virchow described multilocular ulcerative hydatid of the liver, and since that day the problem of the origin of this peculiar condition has much perplexed parasitologists.

This tumour, now generally called alveolar hydatid, macroscopically looks like a solid tumour, consisting of a hard stroma containing innumerable little irregular cavities, in which is a jelly-like substance formed by small hydatid membranes. In section the tumour looks porous and has been compared to a piece of brown bread or a fine sponge. The size of the largest cavity is hardly larger than that of a pea. There is, in consequence, practically no hydatid fluid, merely a jelly-like material, and there are never any free hydatids present. There is no peripheral encystment; it has diffuse, uncertain boundaries like those of a malignant neoplasm. Histologically, it shows a fibrous stroma, more or less necrotic and amorphous, often more or less calcified, and generally containing many giant cells in the neighbourhood of the parasitic elements. Embedded in this stroma are minute, irregular hydatid vesicles which may be recognized by means of their refringent, stratified cuticle, lined internally with the fine germinative layer. They are mostly sterile, but some contain brood capsules and scolices.

The development of the lesion is characterized by a double process—a peripheral infiltration of the liver by the parasitic elements and a central necrosis and progressive excavation of the parasitized mass. The lesions are diffused into the healthy surrounding tissue by means of the cells of germinal layer which are much exaggerated and form buds which tend to send out roots into the host tissue, thus forming reticulated masses which are only later cuticularized. This cuticularization is irregular, and spherical cavities as a rule are not formed. The close contact of the germinal layer allows active diffusion of the hydatid toxins, with inflammation and cellular necrosis. The parasite extends peripherally, whilst the centre breaks down. By its infiltrating character, alveolar hydatid behaves like a malignant neoplasm. It invades the lymphatics and gives rise to specific satellites. It also invades the blood-vessels, especially the veins, and the small emboli which result give rise to new multiple, metastatic foci in the lung, brain and elsewhere. During this time, the infiltrated mass, deprived of blood-vessels and necrosed by the hydatid toxins, breaks up and becomes occupied by a central cavity, holding as many as several litres of a serous fluid, often bile-stained and sometimes purulent, with the eventual escape of gas of putrefaction.

These lesions are remarkably constant in character, no matter what organ may be attacked, and the metastatic foci develop identical lesions in the organs where the emboli come to rest. A transition to normal hydatid has never been observed. Its geographical distribution is limited to South Germany, Switzerland and the Tyrol; and to Russia and Siberia. At the same time isolated cases have been recorded in North Germany (5), Italy (1), France (5), and in the Argentine (2). It is unknown elsewhere. Bovine multilocular hydatid has, by many writers, been considered as identical with human alveolar hydatid, but Dévé points out that it differs from the latter in the following respects: (1) On section there is a stout fibrous framework laid down with regularity, limiting the relatively large cavities, which are filled with a jelly-like magma. (2) This jelly-like mass is easily enucleated from the fibrous cells and is constituted by the thick, wrinkled hydatid membranes which are crumbled, giving rise to intracuticular (exogenous) vesicles. (3) Whatever size it reaches there is never central necrosis. (4) The vesicular cavities, very much

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larger than those of human alveolar hydatid, sometimes reach quite a large size—often in the same tumour showing all the transitions between this form and the typical hydatid. (5) The lesion has no tendency to infiltration at a distance and never invades the blood- or lymph-vessels—it always is circumscribed and benign. (6) The cavities are usually seen to be common to several parasitic vesicles, more or less depressed and prolonged in a caseous or amorphous substance, which in due course becomes calcified. (7) At the edge of the cavities, the vesicular membranes do not lie in the fibrous tissue but are in contact with a layer of epithelioid cells giving the appearance of a cylindrical epithelial lining. (8) The parasitic neoplasm grows and progresses by the eccentric development of exogenous vesicles.

The bovine type therefore differs essentially from the human type in its tendency to encyst and in its circumscription, i.e., by its benignity. There is no central necrosis, and no infiltration of the lymphatics. In both types, however, there is the same elementary structure—that of the typical hydatid—a stratified, hyaline membrane, usually lined by a germinal plasmodial layer. But in the bovine type there are transitions to normal hydatid and there is no malignity, i.e., there is an absence of the ultimate penetration of the blood and lymph spaces by naked wandering plasmodial fingers from which the metastases arise. This type is common throughout the world. Dévé believes that this is *not* the bovine form of the human alveolar parasite. The absence of necrosis is not due to age, because in human tumours which have reached the size of an apple the centre has been already excavated. Now the germinal layer has a quadruple function:

(1, 2) Multiplication: (*a*) growth; (*b*) germination.

(3) Elaboration of a specific liquid.

(4) Production of a cuticular substance.

In normal hydatid, these processes go on regularly and concurrently. In alveolar hydatid they are dissociated. The growth-function proceeds more rapidly than does the others (liquid and cuticle), and so sends its penetrating roots into the tissue before it has time to become normal. The hydatid liquid is thus diffused into the tissue. This form owes its virulence to a functional dissociation of the properties of the germinal material, but this dissociation is normal for alveolar hydatid. In the typical development of the normal parasite there are three successive phases, and Dew considers that these can provide the explanation of all the different forms.

(1) The embryo grows rapidly, is active and toxin-producing, causing toxic and inflammatory changes in the tissues, manifested by cellulo-necrotic changes in the cells. If for some reason this were exaggerated on account of multiple contiguous parasites, hypervirulence or special susceptibility, the result would be the production of a lesion resembling alveolar hydatid in every detail. The parasite would extend peripherally; centrally, the local production of antibodies would cause the deposition of cuticular material and check the growth of the parasite (which would be fertile when it obtained food material). Lack of nutrition would ultimately cause central necrosis.

(2) The second stage is the follicular stage, in which the cellular reaction of the adventitial tissues assumes a trizonal arrangement, and the parasite elaborates its fluid and its cuticle. If this stage is reached and persists, the picture in the ox is seen. The persistent cellular reaction of the host seems to inhibit the ideal development of the parasite—possibly deficient cuticle may permit constant passage of toxins and give rise to this persistent reaction.

(3) If the parasite has settled in an optimum soil, the third stage is reached with the unilocular fertile cyst—the balance between host and parasite is perfect. If for some reason the vitality of the parasite is affected, it either dies or produces endogenous daughter cysts. Multiple cyst production is due to the production of

microscopical herniations induced by intercystic pressure forcing the whole thickness through relatively weak parts of the adventitia, which are then secondarily extruded with the formation of separate cysts.

Conclusion.

There has been much discussion as to whether more than one species of echinococcus exists. There is little doubt at the present day that there are several species, two at least of which cause typical hydatids; but there is no reason to believe that the various forms of hydatid found are necessarily those of different species, i.e., a single species may be the cause of all the various varieties. For many years it has been thought that human alveolar hydatid was produced by a special parasite with a limited geographical distribution. The finding of isolated cases, however, in non-endemic spots militates against this hypothesis and its complete absence in any animal renders the continuance of the species impossible, unless one admits the presence of an alternative form in animals. This has been suggested to exist in the bovine multilocular form, but the histology of this variety is totally against this view; it is a form, however, which is invariably sterile and incapable of carrying on the life cycle.

The trend of modern opinion is towards the assumption that all the forms of hydatid are merely manifestations of a single parasite, the variations being due to histological pecularities or special susceptibilities *of the host*.

Section of Urology.

President: Mr. W. Girling Ball, F.R.C.S.

Some Anatomical Factors in Urinary Infections.

PRESIDENT'S ADDRESS.

By W. Girling Ball, F.R.C.S.

The field of urology has been so well covered by this Section during the past six years that I have found it difficult to select a subject for my address. However, as this Section aims at a closer intercommunication between the physician and the surgeon, I have decided to try to unravel certain mysteries of urological interest dependent upon the anatomical relationships within the neighbourhood of the urinary passages.

Urinary infections have been already fully discussed: but mainly as regards the effects of the infective bacteria on the normal urinary passages, to the exclusion of those adventitious causes of infection which are commonly described as playing so obvious a part as to be hardly worthy of investigation. This attitude presumes that there are cases in which no pre-existing abnormality of the urinary tract is to be found prior to the onset of the infective process. The question I wish to raise is whether infections ever persist in a normal urinary tract, and whether we are correct in assuming, in the absence of obvious lesions of the tract, that some external cause is not present.

Investigators of this subject tell us that in certain acute, generalized, infective processes bacteria are found in the urine; examples quoted are the presence of streptococci in acute endocarditis, of typhoid bacilli in enteric fever, and of tubercle bacilli in acute miliary tuberculosis. The presumption is that these bacteria filter through the kidney without giving rise to clinical lesions; indeed, such are seldom demonstrable, and the bacteria usually disappear from the urine on the recovery of the patient. No doubt other bacteria, such as the *Bacillus coli communis*, in infective processes of the alimentary tract, reach the urinary passages. Sometimes the infection persists with the production of characteristic lesions. I will record a case of this kind associated with typhoid fever.

The patient was a cookshop-keeper who, some nineteen years before, suffered from enteric fever; in the interval members of her family had had the disease without her becoming suspect. Nine months before I saw her she developed renal symptoms, and it was only during the investigation of her urine that the typhoid bacilli were found to be still present. A pyelograph demonstrated the presence of a considerable hydronephrosis, the drainage of which and the removal of a tiny stone, probably of secondary origin, led to the permanent disappearance of the bacilli from the urine.

This woman was a "carrier," and her case has always remained in my mind as illustrating a possible explanation of the persistent or recurrent infections of the renal pelvis, namely, the existence of a gross pathological change in that structure.

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Theories based on animal experiments frequently lead to misunderstanding of the condition of affairs when applied to human beings; recent experimental evidence, [1] and [2], however, does indicate that the introduction of bacteria into the blood-stream is not likely to produce a pyelitis unless the kidney is in some way damaged; but if there is congestion of the renal tissues then an infective lesion is likely to ensue. It has been suggested that distension of the renal pelvis may so obstruct the renal vein as to produce such an effect. This indicates the desirability of investigating for the presence of some obstructive lesion of the ureter likely to cause this type of injury to the renal tissues.

Next, let us inquire why it is that the bacterial flora of the intestine are so commonly found in urinary infections, when it is seldom that we can demonstrate lesions in the alimentary tract likely to cause such a condition. Chronic constipation and diarrhœa, it is true, are frequently found in patients suffering from urinary infections, but by no means constantly: in 100 cases of acute, chronic and recurrent pyelitis the bowels acted naturally in no less than thirty-five; in this series there were only two cases in which a definite bowel lesion was recognized, one patient suffering from piles and the other from appendicitis. It is, to my mind, a poor argument to say that because a patient is constipated or has diarrhœa such is the source of his renal infection. However, we have to be content with this as the only evidence of bowel disturbance in the majority of cases. If the bowel is the source of infection, we ought to find urinary lesions in those known to be subjects of some intestinal abnormality; this, as I will show, does not frequently occur. Be this as it may, the character of the bacteria found in urinary infections impels us to believe that the intestine is the only possible site from which the infection can come in the great majority of cases.

As part of a generalized infection, sometimes with involvement of other structures such as the gall-bladder, it is easy to understand that intestinal bacteria should reach the kidney and produce transient lesions; but it is much more difficult to account for chronic infections, which often start without an acute onset, especially when we consider the relatively infrequent occurrence of similar lesions resulting from such recognized infections as typhoid fever. In addition, infections of the kidney due to micro-organisms such as the staphylococcus, derived, shall we say, from a furuncle, usually produce an embolic lesion in the renal cortex. Why is there so little evidence of similar foci associated with the colon bacillus group? It is true that in some cases minute abscesses are found in the renal cortex, but the usual lesions are in the mucosa and submucosa of the renal pelvis. If we agree that these infections are hæmatogenous, the only explanation is that transient foci of infection in the cortex have preceded the pelvic lesions. The explanation, surely, would be more acceptable if it were possible to demonstrate the presence of some obstruction lower down in the urinary tract, especially if that were likely to cause congestion which would render the kidney a suitable ground for infection by bacteria filtered through it from time to time. The persistence of such an infection would be aided by the retention of infected urine in the renal pelvis causing constant re-infection; in other words, the absence of such an obstruction does not explain the failure of the drainage of the renal pelvis sufficiently to permit the infection to clear up.

I have investigated a large series of cases in order to try to define the existence of predisposing factors, more especially those having an external anatomical relationship to the urinary tract.

In the first place let me show you a record of 200 consecutive bacteriological investigations of infective processes occurring in the urinary passages.

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(1) Those associated with the conditions likely to cause obstruction in the urinary passages :—			
Renal calculus	30		
Ureteric calculus	2		
Vesical ,, ...	2		
Bladder diverticuli	2		
Enlarged prostate	43		
Urethral stricture	12		
Ureteric ,, ...	1		
Carcinoma of the prostate ...	6		
Carcinoma of the bladder ...	9		
Pyelitis of pregnancy	3		
Movable kidney	3		
Abnormal renal artery	4		
Renal growths	4		
Hydronephrosis...	4	...	125
(2) Secondary infections of other conditions :—			
Tuberculosis	2	.	2
(3) Extraneous causes of infection :—			
Appendicitis	9		
Salpingitis	4		
Diverticulitis	3		
Fæcal fistula	3		
Uretero-vaginal fistula	1	...	20
(4) Unclassified causes :—			
Cystitis	16		
Unilateral pyelitis	12		
Bilateral ,, ...	20		
Nephritis	5	...	53
			200

It is seen that in about 63 per cent. of these cases the urinary passages showed some pre-existing abnormality, and in a large number the records indicate that it had produced dilatation of the urinary passages above the site of the lesion. This supports the belief that dilatation of the urinary passages is largely responsible for the incidence of the infective process, whether it be by providing a suitable field for bacteria to live in, or by lowering the resistance of the kidney to infection. It is reasonable to suppose that under these circumstances the tissues of the kidney may become so altered as to permit of the transmission of bacteria which circulate in the blood-stream. The sites of origin of the bacteria suggested by various observers are numerous, but in the majority of cases it is natural to presume that they are transmitted from the intestinal tract ; in this series in 136 a pure culture of the coliform bacillus was obtained ; twenty-six contained coliform bacilli associated with streptococci and staphylococci ; twenty-two gave a pure culture of staphylococci ; nine gave a pure culture of streptococci, and six a mixture of streptococci and staphylococci. The streptococci present were mostly of the fæcal type.

The second largest group is that in which, after complete investigation, no predisposing factor was discovered which could be held to be responsible for the pyelitis, pyelonephritis, cystitis, or nephritis. When the largest group of infections is associated with some lesion likely to produce obstruction, it is only natural that one should explore for some similar lesion in the remainder, especially in the cases of unilateral infection which form a large proportion.

However, it is not my intention to enter more deeply into a discussion in this direction, except in so far as it concerns the subject of my investigation. Most of us assume that the bacterial transmission is made via the blood-stream from the bowel ; but I would submit that too seldom do we attribute the infective processes to a direct contact between the two tracts. These are the premises on which I have carried out this investigation, for the incompleteness of which I apologize. I have assumed a patient suffering from an infection of the urinary tract who has been submitted to the ordinary and elaborate technical methods of investigation, and will

try to demonstrate that in the absence of a lesion within the tract, there may exist a causative factor outside it, capable of inducing an infection by contact and even of producing an obstructive lesion. I have also investigated the records of a large number of patients suffering from known pathological conditions of the alimentary tract, and have tried to obtain some idea as to how frequently urinary infections occur in association with them. This line of investigation was borne in upon me by the recognition that the diagnosis of pyelitis is often made in a very loose fashion, without investigations which are necessary to define the presence of some associated factor.

Pyelography has so helped us to elucidate some problems associated with infections that in cases of difficulty it ought to form part of our systematic investigation. In illustration of this, let me mention three cases seen during the last year.

Case I.—A man who, for six years, had been suffering from attacks of renal colic, suggestive of the presence of a calculus. Owing to the negative evidence of radiography and on the grounds that his urine contained pus and was infected with *Bacillus coli communis*, he was treated for pyelitis on the original and many recurrent occasions. A pyelography at the end of this period demonstrated the presence of a hydronephrosis typical of that produced by a calculus, which was subsequently proven to be present.

Case II.—A woman who had been treated for chronic pyelitis for four years, until she suddenly developed an acute exacerbation which led to a more complete investigation of her case. Her chronic ailment was proved by pyelography to be dependent on the presence of a large distension of the renal pelvis associated with an abnormal renal vessel, which passed across a constriction at the uretero-pelvic junction.

Case III.—A man, thought to be the subject of pyelitis and treated as such for a period of over two years. It is true that during the later months he developed a swelling in his abdomen, which threw some doubt on the diagnosis, but he was still treated for his infection, chiefly by vaccine therapy. X-ray pictures, however, showed that there was a large tumour present, which the pyelogram demonstrated to have so twisted his kidney that the ureter came to lie over the surface of it and was thus obstructed.

Each of these patients, previously treated without benefit, was suffering from an obstructive lesion which, though not demonstrable by the ordinary methods of investigation, was readily recognized by a pyelographic examination. Since the introduction of pyelographic examinations this variety of case is recognized more and more frequently and surgeons are less and less inclined to be satisfied with the diagnosis of pyelitis, pyelonephritis or cystitis, as a primary condition. Still, there are many cases in which we are driven to such unsatisfactory diagnoses. And often we cannot diminish their number by checking our findings by operative or post-mortem examinations. However, there are other lesions outside the urinary tract which may produce similar conditions, as I shall now proceed to show.

The frequency with which alimentary bacteria are found in urinary infections suggests investigation of the intestine. To this end I have collected a large number of cases in which urinary symptoms and infective lesions were dependent upon an anatomical relationship between the bowel and the urinary tract, although such a connexion had not been suspected prior to the recognition of the actual lesion.

Appendix Cases.

I have investigated 200 cases of appendicitis, proven by operation, in which records of urinary symptoms and the condition of the urine have been made. It will be seen that all varieties of appendicitis are included:—

Chronic appendicitis	25
Subacute ,, ...	17
Acute ,, ...	72
Gangrenous ,, ...	35
Appendix abscess	34
Appendicitis with general peritonitis	6
Pyoceles	11
	200

In investigating 5,000 cases of appendicitis, Gladstone and Wakeley [3] place the appendix in 69 per cent. in the retrocæcal position, and in 27 per cent. as hanging over the brim of the pelvis, so that in the majority of cases of appendicitis it is reasonable to suppose that some part of the urinary tract must come into very close contact with the inflammatory process. The lesions of the appendix, varying from catarrhal, acute inflammatory, gangrenous lesions to perforation with abscess formation, &c., are not equally liable to involve the surrounding tissues; but in acute stages, especially those of gangrene and abscess formation, we should expect that infection would, from time to time, involve the ureter or renal pelvis, even though the peritoneum separates them, and still more so when the appendix lies behind the cæcum uncovered by peritoneum.

Even in chronic cases, in which the appendix so commonly becomes bound down to the posterior abdominal wall, in the neighbourhood of the ureter, it might be anticipated that the structure would often become involved, and adhesions might lead to dilatations of the renal pelvis, thus affording a site for infection with the *Bacillus coli*. Even in the absence of actual contact of the appendix with the ureter, a peri-ureteritis must exist fairly frequently and this might lead to subsequent changes in the ureter. Large pelvic and perinephritic abscesses would appear to form potential sources of infection of the renal pelvis, ureter or bladder. Even if we exclude direct contact with the urinary tract, would not an acute or chronic infective lesion of this character produce an excellent focus for origin of a hæmatogenous transmission to the urinary tract? But what do we find? In only 29 of the 200 cases were urinary symptoms present at all, and in only 12 of these (6 per cent.) was a bacterial infection or a urinary lesion present. It is interesting that in each of the twelve cases in which urinary infection was present, the urinary symptoms, which had in each instance run a chronic or recurrent course, so overmasked the disease of the appendix as to lead to a diagnosis of primary urinary disease. Such is not the usual sequence of events, for appendicitis is frequently diagnosed when a lesion of renal origin is really present. But in these twelve cases some part of the urinary tract was implicated as a result of chronic appendicitis, although the relationship was not discovered, in some cases, until an acute attack supervened. This naturally leads us to wonder whether a chronic appendicitis may not be often responsible for many cases of right-sided infection of the urinary tract. Let me illustrate rather in detail what has occurred, for the cases are instructive.

The urinary symptoms most commonly complained of amongst these twenty-nine cases are increased frequency of micturition and painful micturition. Increased frequency was the only symptom mentioned by two patients, and was so prominent that it nearly led to a wrong diagnosis. However, there was no evidence of a urinary lesion, and physical examination pointed to disease of the appendix. In twelve other cases in which these symptoms were prominent, a chronic lesion of the appendix was found six times, an acutely inflamed appendix twice, a pyocele twice, and a pelvic abscess once. The appendix was adherent to the right side of the pelvis in five of the chronic cases and apparently had no relation to the urinary passages in the sixth. In the acute cases the appendix was placed retrocæcally; the abscess was in the pelvis; and the pyoceles had no relation at all, being wrapped up in inflamed omentum. The symptom of increased frequency of micturition completely disappeared with the removal of the appendices. It is thus seen that this symptom was most frequently associated with a pelvic-placed appendix, which can no doubt be explained by the pain induced with a distended bladder in the neighbourhood of an area of localized peritonitis. In eleven of these fourteen cases, neither pus nor bacteria were found in the urine; in the remainder both were present. In one case, in which the appendix was lying over the brim of

the pelvis, although neither pus nor bacteria were found, a painful, swollen right kidney could be felt. Among the chronic cases with recurrent attacks, this symptom was a prominent feature of each attack.

Painful micturition, apart from or accompanying increased frequency, was the next most prevalent symptom and appeared either before, during, or after the act of micturition. The pain was situated either in the hypogastric region or along the course of the urethra. Pus and bacteria were found in two cases. Pain referred to the end of the penis was associated with an acutely inflamed appendix in the retrocæcal position on one occasion and simulated renal colic very closely. Pyuria was present in one case in which no urinary symptoms were present and was discovered accidentally during a routine examination. Hæmaturia did not occur in this particular group, but most of us are familiar with it. The degree of hæmaturia is variable; it may be so small as to be only demonstrable on microscopic examination, or so severe as to cause a secondary anæmia. The source of this hæmaturia is doubtful; it may come from one or two sources; either from the site of attachment of the appendix to the urinary tract, or from the submucosal tissues of the renal pelvis. Urinary infections or the involvement of the urinary tract in appendicular disease is thus seen to occur, but not so frequently as symptoms would suggest.

The cases which I have been reviewing are taken from consecutive admissions to hospital. I will now record some cases of appendicitis which I have met with, and which appear to have specially instructive interest. In each instance in this group the urinary symptoms were the prominent features, and in none was the appendix considered as a possible cause for these symptoms until an unexpected event occurred which led to the recognition of the actual conditions.

Case I.—A doctor, aged 54, was seized with an acute attack of cystitis, severe in character, associated with great pain on micturition, which was frequent, and was accompanied by considerable hæmaturia of several days' duration. The attack ran the usual course of the so-called "coli cystitis"; the patient made a complete recovery after a few weeks, except that the bacilluria persisted. Some nine months later he felt a pain in his hypogastrium which he took to be another attack of cystitis, especially as he was on one occasion seized with such severe pain on micturition as to cause him to collapse. However, there was no recurrence of the hæmaturia or the increased frequency of micturition; the pain settled in the right iliac fossa on the next day and it was clear that the patient was suffering from appendicitis, which was confirmed by the fact that he had a painful swelling on the right side of his pelvis which could be felt by the rectum. The urine still contained the *Bacillus coli communis*, but there was no pyuria or hæmaturia. An exploratory laparotomy was performed and a small piece of intestine adherent to the posterior aspect of the bladder was discovered, covering an acutely inflamed appendix, which could only be freed with difficulty from the posterior wall of the bladder. In doing this an apical perforation was discovered which was only closed by the bladder wall. The urine almost immediately became free from bacteria and remained so; neither has there been a recurrence of urinary symptoms after a period of many years.

That the original attack of cystitis was secondary to appendicitis appears to be proved, for although he had no further attack of cystitis, the bacilluria which had persisted for a period of nine months disappeared with the removal of the appendix. This must be regarded as a case of direct infection through the bladder wall. I have met with four other cases of a similar character, in which bladder symptoms were so prominent as to mask any symptoms which might have been recognized as of appendicular origin.

Cases II & III.—The patients were small girls, about 12 years of age, who had been repeatedly treated in hospital for recurrent attacks of cystitis with a colon bacillus infection. In the intervals the urine completely cleared up and the patients became free from symptoms. Eventually, both developed typical attacks of pelvic appendicitis. Pus was found at the apex

of the appendix of one, and a gangrenous appendix was present in the other. In each instance this structure was firmly adherent to the wall of the bladder. Coincident with the removal of the appendix the attacks of cystitis ceased and did not recur.

Case IV.—Patient, a man who had been treated for many months with bladder irrigations for chronic cystitis, for which no obvious cause could be discovered. The mucosa of the base and the posterior bladder wall was swollen and œdematous, involving both ureteric orifices, and there was considerable pyuria. Eventually, an acute attack of appendicitis developed, the appendix being found firmly adherent to the back of the bladder in a gangrenous condition, covered over by a mass of inflamed omentum. Subsequent to its removal the cystitis cleared up rapidly.

Case V.—In this case the diagnosis was not so difficult, although in its attachments it was similar to the other cases: a cystoscopic examination demonstrated a small fæcal fistula, high up on the bladder wall, through which minute fæcal particles were observed to pass.

The inference to be drawn from these cases, in each of which there was more than one attack of cystitis, must be that the appendix was the factor responsible for the infection, and it is very clearly demonstrated that the local attachment of a part of the intestine to the urinary tract may be a cause of chronic persistent or recurrent infection, presumably by direct transmission.

In about 30 per cent. of all cases of appendicitis the appendix hangs over the pelvic brim, and thus must frequently lie near the pelvic portion of the ureter or the bladder wall. Amongst these cases it has not involved these structures in the primary acute phases of appendicitis, which is not surprising, for in these days appendicitis is usually recognized at an early stage, and the offending organ is removed before any serious adhesion to surrounding structures can take place. Still, late diagnoses are not uncommon. It is remarkable, therefore, that we do not see more cases of urinary infection associated with this condition. However, the resistance of the peritoneum and the bladder wall to the transmission of infection is very considerable, a fact well illustrated in this series, for only once in a collection of thirty-four abscesses did an infection of the urinary tract take place.

I now turn to the abdominal ureter and the renal pelvis. I must admit that I cannot remember having seen the ureter exposed during the removal of an appendix; nor have I seen any complication which suggested that the ureter had been damaged. The following case, however, does illustrate the point that the ureter may become involved in this disease.

A woman, aged 46, six weeks before I saw her, had an attack of diarrhœa and vomiting, associated with hæmaturia and markedly increased frequency of micturition. She had tenderness in the left iliac fossa and in the right post-renal angle. The urine obviously contained blood. She had apparently been bleeding for a considerable time, as her red blood-cells were diminished to 2,960,000 per c.mm., and the hæmoglobin content was 52 per cent.; the white blood-cells were 9,600 per c.mm. The urine was sterile. X-ray evidence was negative. By cystoscopic examination the blood was seen to be coming from the right ureteric orifice. A pyelographic examination demonstrated a considerable distension of the renal pelvis, suggesting the presence of a kink of the uretero-pelvic junction. The bleeding became so severe that an exploration of the kidney was made. It was found to be considerably enlarged, from a distension of the renal pelvis. The upper portion of the ureter for a short distance along its course was also dilated, but at the lower limit of this dilatation no cause could be discovered, nor was there any definite constriction. I could see no alternative on the evidence that was before me but to remove the kidney, largely on account of the woman's condition. It was, indeed, disturbing on opening the kidney to find no abnormality which would account for the hæmaturia or the dilatation of the pelvis. The pelvic mucosa, however, did show a large number of translucent vesicles on its surface, which, on microscopic section, proved to be œdematous patches surmounting an area of submucous hæmorrhage; the kidney tissue itself appeared normal. It was still more disconcerting to find subsequently that the hæmaturia persisted. I should add that at no time was there any pus or evidence of bacterial infection in the urine. The

patient was sent to a convalescent home and I did not hear any more of her for three months, when she returned with a typical attack of appendicitis, the urine still containing blood and now for the first time heavily infected with *Bacillus coli communis*. A gangrenous appendix was removed from an abscess cavity which was lying behind the cæcum and the wound was drained. The hæmaturia and the infection disappeared incidentally with the removal of the appendix and the patient made a complete recovery.

On looking back it is obvious that the original symptoms were of intestinal origin. However, the reference of the pain to the post-renal angle, the prominence of the hæmaturia, and the pyelographic demonstration of a hydronephrosis were sufficient evidence to prevent the diagnosis of appendicitis being made. The removal of the kidney was carried out as an emergency operation, and although it was an unnecessary removal, interesting facts were discovered. The extravasated blood in the submucosal tissues of the renal pelvis in connexion with the hydronephrosis is interesting, as it was present in the absence of infection. Another point which this case demonstrates is that the infection may come from direct attachment of the intestinal tract to the ureter. This may be regarded as a case of some importance in explaining the view above propounded, for it demonstrates dilatation of the renal pelvis and other changes without the presence of infection, resulting probably from a long-standing adhesion of the appendix. On five other occasions I have met with cases previously diagnosed and treated as pyelitis which were dependent on inflammations of the appendix. In three, acute appendicitis supervened, and in two, a chronic inflammation. In each instance the appendix was lying in the retrocæcal position, presumably involving either the ureter or the renal pelvis, quite certainly the latter structure in two of the cases. In one, a bacilluria persisted after removal of the appendix, but in the remainder, both the symptoms and the evidence of infection completely cleared up. It is unnecessary to quote all these cases, but the one in which the infection remained has another bearing.

A girl, aged 24, who at intervals during a period of three years, had been in hospital for extended periods with symptoms of cystitis and infection of the urinary tract. The urine on each occasion contained pus and *Bacillus coli communis*. The cystoscopic evidence and ureteric catheterization had always shown that it was a unilateral infection originating in the right kidney. Radiographic and pyelographic examinations gave negative evidence. It was difficult to obtain a pyelogram satisfactorily, for the pelvic wall was apparently rigid and would not distend at all; although it gave her no pain the opaque material always ran back along the side of the catheter. On each occasion that she came to hospital, diuretic treatment and attention to the bowel relieved her, so that during an interval of nine months preceding her last admission she had had no symptoms. She always exhibited marked evidence of intestinal stasis. During her last attack her condition did not respond to treatment and for the first time she developed a pain in the right renal region. After giving her a barium meal which showed that her alimentary tract was normal, I explored the abdomen, and discovered a very highly placed cæcum with its lower pole lying above the lower pole of a small kidney. The appendix was adherent to the cæcum along its posterior wall and had obviously been in trouble. It was also in very close relationship and attached by loose adhesions to the front of the kidney. On exploring the abdomen further, I found that she had a tremendous hypertrophy of a very long loop of pelvic colon, which was no doubt responsible for the intestinal stasis. After removal of the appendix, the pyuria which had persisted up to this moment immediately subsided, but the infection still remained, as also did the pain in the right kidney, which only disappeared with the subsequent removal of the kidney which was infected.

This is not so clear a case of involvement of the urinary tract in an intestinal lesion as the others, but the close connexion between an abnormally highly placed cæcum and the kidney is very suggestive in a case of right-sided unilateral pyelitis. It will be observed that constipation was severe, and for this there was a definite cause. It may be that the appendix did play a part in the production of the pyelitis,

but here is an excellent example of an abnormality of the intestinal tract which might form the primary focus for a hæmatogenous renal infection.

The possibility of a combination of use of pyelograms, opaque catheters and cystographies, with barium meals and enemata, as a useful method of diagnosis is suggested by these records, for if the appendix should fill with opaque material, its close relationship to the structures of the urinary tract might be demonstrated, especially if advantage is taken of making stereoscopic pictures; but it would be difficult to separate the shadows owing to the opacity of the barium. This was a new idea to me and only one opportunity has presented itself for a trial.

This is the case of a woman, aged 68, who was complaining of pain in the hypogastrium and an hourly frequency of micturition both day and night. She stated that during the past five or six years she had had several similar attacks and that the pain frequently radiated down her right leg and through to her back. On investigation I was unable to find any cause for her symptoms at all. Investigations of the urine, cystoscopic and radiographic examinations were negative, with the exception that at one point in her bladder there was a small area of mucous membrane which did suggest the presence of some inflammatory lesion. The combination of a bismuth meal and a cystography was tried. The meal showed that she had a long appendix hanging over the brim of the pelvis, but although it ran down towards the bladder there was a distance of about 1 in. which separated it from the bladder shadow. However, I did explore the abdomen and found the appendix firmly adherent to a dense white scar in the sulcus between the bladder and the uterus, but it had no definite attachment to the bladder. However, the removal of the appendix led to the disappearance of the frequency of micturition, so that when she was discharged from hospital she could hold her water for five hours and has continued to do so,—a period of comfort which she has not experienced for many years.

Although this radiographic examination was not convincing, the result obtained suggests that it is worthy of trial.

This relationship has been recorded by Tormey [4], in a case of appendicitis associated with hæmaturia, in which the appendix was adherent to the ureter. Ashurst and Woodson [5] record a case in which the diagnosis of a ureteric calculus was made owing to hæmaturia and pain; they emphasize the difficulty which may arise in diagnosing appendicitis in the presence of hæmaturia; in their case a gangrenous appendix was found. Lincoln [6] records three cases of right-sided pyelitis, which suggested appendicitis, but which were correctly diagnosed as pyelitis by the presence of pus in the water. He also records four cases of appendicitis and pyelitis co-existing, an acutely inflamed appendix in each case being found in the retrocæcal position. In one the pyelitis cleared up quickly. In the rest, the pus remained for some time, but eventually disappeared. The diagnosis of appendicitis seems to have been easily made in these cases, in contradistinction to those described above, in which the symptoms of pyelitis or cystitis preceded for a considerable period any definite evidence of an appendicular origin. Personally, I have not met a case of a rupture of an appendix abscess into the urinary passages beyond the fistulous tract already mentioned, but Roux has reported a case in which an abscess burst into the renal pelvis, and Chrelitzer has described another in which he suspected, but did not prove, that rupture had taken place into the ureter.

Intestinal Fistulæ.

Intestinal fistulæ may be produced in connexion with other structures than the appendix. In the early stages these may be very small and difficult to define. The passage of wind and fæcal material per urethram is usually the first evidence. There must, however, be a premonitory stage during which the infection may occur, and even when the fistula has formed it may not remain continuously open, so that in the intervals there is no indication of its existence beyond an infection of the urinary

tract. These fistulæ most frequently arise in cases of diverticulitis of the pelvic colon. Sometimes, however, their origin is unconnected with this condition.

A woman, aged 35, came under my care and said that she had been operated upon some sixteen years before for a ruptured ectopic gestation. This operation was followed by a pelvic suppuration, which was drained per vaginam as well as through the abdominal cavity. Six years before I saw her, she began to show evidence of cystitis. The urine was heavily infected with *Bacillus coli communis* and with a considerable amount of pus. A few months before I saw her she had the suspicion that she was passing wind by her vagina and it was thought that she might have a recto-vaginal fistula, but this could not be found. A cystoscopic examination demonstrated that just above the right ureteric orifice was a small papillary projection, in the centre of which was a small depression, through which a catheter could be passed. The bladder wall showed evidence of a gross cystitis. On removal of the catheter a tiny bead of fæcal material was seen to enter the bladder. The abdomen was opened and the fistulous tract was discovered with great difficulty, for it was buried amongst adhesions and enveloped by a small piece of intestine. It was a communication between the sigmoid and the bladder which was adherent to this structure on the right side. After the separation of the tract, which would only admit a very fine probe, the opening in the intestinal wall was easily closed, but that in the bladder, owing to the dense scar tissue, was extremely difficult to deal with. The wound was made to heal satisfactorily and within a very short period of time the bladder became free from infection, and so remained for at least three years.

Simple fistulæ of such a nature being uncommon are unlikely to cause many cases of infection of the urinary tract; but before leaving the question of urinary infection attributable to direct contact with the bowel, the influence of diverticulitis and colonic neoplasm must be mentioned. These conditions usually bring about infection by direct implication of the urinary passages in their disease processes. Diverticulitis might conceivably behave in much the same way as the appendix, but experience does not bear this out. A fistula is the common lesion for which this condition is responsible. Telling and Gruner [7] relate that in a series of 280 cases of intestinal diverticula adhesions between the sigmoid colon and the bladder were found in 33 cases (12 per cent.), either by direct contact or by the intervention of an abscess cavity. The same observers are of opinion that lesions of this character more commonly result from diverticulitis than from the infiltration and perforation of growths, which is the other common cause of intestino-vesical fistulæ. I have seen a case of diverticulitis which is an illustration of the early signs and symptoms.

A man of about 60 was found to be suffering with a severe infection of the urinary tract, characterized by the symptoms and signs of cystitis and accompanied by rigors with a prolonged period of high fever. There was also evidence of pyelitis, causing severe pain in the left lumbar region. The patient stated that he frequently passed wind in his water, which was obvious when I saw him, but no fæcal material had ever been observed. It was known that he had had a swelling in his left iliac fossa, running along the line of his pelvic colon, for about twelve years; this was considered to be the cause of marked constipation, which had increased during the preceding twelve months.

At the time that I saw him this swelling was excessively tender and the patient was very ill. A cystoscopic examination failed to demonstrate any fistulous opening. The urine withdrawn from the bladder was exceedingly foul, suggesting the presence of fæces in it. The bladder was cleansed quite easily, but was the seat of severe cystitis. Turbid urine was discharging from the left ureter, and the conclusion was arrived at that there was some communication between the bowel and the ureter. It was considered at that time that the patient would not stand an exploratory operation; he recovered from the severer symptoms, however, and was sufficiently well some weeks later for a colostomy to be performed. By this time large quantities of fæces were being passed, and the surgeon who operated thought that the fistula must have perforated into the bladder, although he was unable to confirm this point.

I have seen, during the last two years, another such case in a man; the patient had originally suffered from a pericolic abscess which drained so well as eventually to allow

of the performance of a colo-colostomy; but later on he noticed a little blood in his water, followed two weeks later by the passage of fæcal material. He continued to pass the fæces by the bladder and also the urine by his rectum.

Diverticulitis, by its early adhesion to the bladder, does give rise to evidence of vesical irritability. If it were possible to recognize the condition at this stage, resection or some form of plastic operation might prevent the occurrence of the dreadful calamity of perforation; it is seldom, however, that patients are seen until the perforation has occurred, for the interval between possible involvement and perforation is so short as not to permit of the relief which might be obtained by colostomy or short-circuiting.

Carcinoma of the Colon and Rectum.

I have collected fifty cases of carcinoma of the large intestine, the majority of which were situated in the pelvic colon and rectum; this was not done so much from the point of view of demonstrating how often the growths involve the urinary organs as to find out how often infections occur as the result of acute and chronic in testinal obstruction.

In each of these fifty cases the functions of the urinary organs and the character of the urine are recorded. In three cases only was any urinary abnormality discovered, and it is interesting to note that in each there was some mechanical factor which could be held responsible for the infection of the urinary tract. One of these was a rectal growth of such a size as to fill the pelvis completely, thereby causing difficulty of micturition although not producing a urinary infection. A second similar growth was responsible for a left-sided infected hydronephrosis, the ureter, as demonstrated at a post-mortem examination being embedded in the growth. The third was a carcinoma of the pelvic colon, the first evidence of which was indicated by the passage of wind and fæces per urethram. None of these cases, although associated with ulcerative lesions and intestinal obstruction, was responsible for a hæmatogenous infection, although they might be expected to be productive of such.

Colitis Cases.

Colitis, whether of the simple or ulcerative variety, is frequently quoted as causing infections of the urinary passages, but this is not upheld by the facts. In 100 consecutive cases of pyelitis of which I have examined the records, colitis was not present in a single instance; in fact in none of this series was a definite intestinal lesion recognized, whereas in fifty-eight cases of colitis, thirty being of the ulcerative type, urinary lesions were only found in three cases. In these each patient was suffering from ulcerative colitis; two of them had definite evidence of pyelitis and were infected with *Bacillus coli communis* and *Staphylococcus pyogenes aureus* respectively; in the remaining cases there was no evidence of a lesion of the tract beyond the presence of the colon bacillus in the urine. It cannot be said therefore, that this condition commonly predisposes to the production of urinary nfections.

I have, however, the permission of one of my colleagues to quote the case of a woman who suffered from colitis for a year, and then developed two attacks of pyelitis associated with a coliform bacillary infection. The ulceration of the intestine was severe and had led to a contraction of the pelvic colon which is being dealt with surgically. Also the case of a man who had been suffering from attacks of pyelitis extending over five months, but who remained free after attention to his bowel, which was the seat of a simple colitis with an atonic condition of its musculature. The infection of the urine in this case was with a streptococcus which completely disappeared with the abatement of the symptoms.

12 Ball: *Some Anatomical Factors in Urinary Infections*

SALPINGITIS.

The chronic infections of the Fallopian tubes are so closely allied in their characters to similar conditions of the intestinal tract that I have collected 116 cases in a consecutive series of lesions of these structures. As with appendicitis, symptoms referable to the bladder or other portions of the urinary tract occur with or without infection. The cases examined are as follows:—

Left salpingitis'	30
Right ,, ...	12
Double ,, ...	44
Left pyosalpinx	11
Right ,, ...	7
Double ,, ...	12

Thirty-one of these had increased frequency or a painful micturition, or both. This proportion is higher than in the cases of appendicitis, presumably owing to the relatively closer anatomical situation of the structures involved. The symptoms occurred almost equally in the acute and the chronic cases, eight in acute salpingitis and seven in acute pyosalpinx, fourteen in chronic salpingitis, and two in chronic pyosalpinx. In two of the cases of pyosalpinx difficulty of micturition was caused by the size of the tumour, which had lifted the bladder into the abdomen and itself filled the pelvic cavity. The frequency, however, with which lesions of the urinary tract are associated with these conditions corresponds almost exactly with that of the appendix, namely, in eight cases (6·2 per cent.). In all the cases the *Bacillus coli communis* or the *Streptococcus fæcalis* was the offending micro-organism. Unfortunately, cystoscopic examinations were not made; it is thus not possible to give the exact nature of the lesions present. The records, however, are of sufficient interest to be related.

Case I.—Aged 21. Suffering from pain in the right loin of three days' standing, ushered in with a rigor and the symptoms of increased frequency of micturition. The urine contained a considerable quantity of pus and was infected with *Bacillus coli communis*. This patient had been under observation for some time with a right-sided salpingitis and a profuse vaginal discharge.

Case II.—Aged 36. Complaining of a right-sided lumbar pain, extending into the iliac fossa and accompanied by hæmaturia. The frequency of micturition was normal. Subsequently the pain in her kidney increased, as also did the frequency. She had been treated for a similar condition in the left kidney two years previously. The uterus was firmly fixed to the right side of the pelvis as the result of an old salpingitis. The urine contained pus and was infected with the *Bacillus coli communis*. Her symptoms were relieved by rest in bed and diuretic treatment, but she returned a year later with similar symptoms and an attack of hæmaturia. The patient, however, refused to be operated upon.

Case III.—Aged 44. Complained of increased frequency of micturition and mild pain in the left loin. Pus and coliform bacilli were found in the urine, both of which disappeared on the removal of a left-sided pyosalpinx of the chronic type.

Case IV.—Aged 32. Admitted with difficulty of micturition, pain in the hypogastrium and right loin. This patient was found to be suffering from a right-sided pyosalpinx the size of a coco-nut. The urine contained a considerable quantity of pus and was infected with a coliform bacillus and the *Streptococcus fæcalis*. The symptoms and the infection cleared up with the removal of the pyosalpinx.

Case V.—Aged 43. Complaining of pain in the hypogastrium and a half-hourly frequency of micturition. The urine was purulent and was infected with *Bacillus coli communis* and *Streptococcus fæcalis*. A right-sided pyosalpinx of considerable size, with obvious recent adhesions to the back of the bladder and the side wall of the pelvis, was removed. The urinary symptoms and the infection cleared up completely.

Case VI.—Aged 21. Complaining of increased frequency of micturition and acute abdominal pain for three days. Pus. *Bacillus coli communis* and the *Streptococcus fæcalis*

were found in the urine. The left tube was firmly adherent to the left latter wall of the pelvis and removed and was found to contain the same bacteria in its lumen. The bacilluria still persisted, but the symptoms were relieved.

Case VII.—Aged 29. Came under observation with a double chronic pyosalpinx. There were no urinary symptoms, but *Bacillus coli communis* was found in the purulent urine. No operation was performed and there is no record of the condition of the urine on her discharge from the hospital.

Case VIII.—Aged 44. Increased frequency of micturition was a prominent symptom during each of two attacks of acute salpingitis, especially on the occasion when she was relieved by the removal of a large left-sided pyosalpinx. The state of the urine, which had previously contained pus and *Bacillus coli communis*, completely cleared up subsequent to the operation.

It is noteworthy that the symptoms for which the patients came under observation, with one exception, indicated the presence of a lesion of the urinary tract. These were relieved, with two exceptions, together with the infection, by the removal of the infected tube. In four of these cases the patients were undoubtedly the subjects of pyelitis, and it should be noted that the affected kidney corresponded to the side of the affected tube. In the absence of the close contact between the tube and the bladder in these cases, as was exhibited in the appendix cases, and in the absence of cystoscopic examination and ureteric catheterization, it may be a justifiable assumption that some of the other patients were the subjects of pyelitis. If this is assumed, infections of the urinary tract may have been in each instance due to obstructions of the ureter, brought about by the same mechanism as that associated with the pregnant uterus. Whether this be true or not this group does not illustrate the close contact exhibited by the other cases, although it might be expected to do so. In a manner similar to the other lesions described ruptures of a pyosalpinx into the bladder do from time to time occur, thereby producing an inflammatory diverticulum. I have met with this condition on two occasions, in one case with a simultaneous rupture of a pyosalpinx into the bladder and rectum, thereby producing a vesico-intestinal fistula.

Conclusions.

Let me summarize the facts that appear to me to result from these investigations. The number of cases quoted is small and tends to exaggerate the importance of this question. It should not, therefore, be regarded as representing the actual frequency with which this kind of lesion is found. It is clear to my mind, however, that the adhesion and the anatomical proximity of the inflammatory lesions of the intestinal tract and the pelvic viscera are responsible for a higher percentage of cases of urinary infection than I, at least, was aware of. The association of urinary symptoms with intra-abdominal conditions is familiar to us all; but how frequently, when we are called upon to differentiate between, shall we say, an acute appendicitis and an acute pyelitis, do we rely upon the finding of pus and bacteria in the urine in casting our opinion in favour of the latter, without questioning as to whether the appendix may not be the causative factor after all.

In reviewing these cases it will be seen that in almost every instance it was the onset of an acute flare-up of an intestinal or pelvic lesion during the course of a chronic urinary infection that led to the discovery of the actual cause of the trouble. May it not be that many instances of chronic infections of the urinary tract may depend on a similar condition but that we do not recognize them because of the absence of the acute flare-up? In other words, are we correct in assuming that infections of the urinary tract are always due to hæmatogenous infection through the kidney, to the exclusion of contact lesions which are difficult to define? Surely, our efforts should be directed towards the discovery of the latter, more especially as there

is so little evidence that primary foci of an inflammatory kind in the alimentary tract do produce infections of the urinary tract. Let me add, that even if the infection is not by direct contact but is of hæmatogenous origin, it is possible that similar lesions to those above described may still be playing a part. The adhesion of a chronic lesion, or the obstruction caused by an acute lesion of the alimentary tract or pelvic viscera, to the ureter, may be of such a nature that, although not obliterating the lumen of the latter, it may act in such a manner as to cause a dilatation of the renal pelvis and congestion of the renal cortex, and thus provide a condition of affairs amenable to the persistence or recurrence of an infection. It is not at all my intention to suggest that direct contact of the urinary passages with infective lesions of the neighbouring structures is the only channel through which these infections take place, but rather to stimulate investigations in this direction with a view to explaining some of those cases of urinary infection for which, to my mind, the explanations at present in use are inadequate.

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War Section.

President—Group-Captain Henry Cooper, D.S.O., R.A.F.

Peace Time Military Surgery.

By Colonel J. W. West, C.M.G., K.H.S., R.A.M.C.

The title of this address may not, at first sight, appear suitable for the War Section of this Society. While the importance of keeping alive the surgical problems and lessons of the Great War should not be forgotten, so much has been written about it that there is little I could add to your knowledge on that subject. To be a useful military surgeon in war it is essential to be a trained surgeon in peace.

The Royal Army Medical Corps exists to be prepared for war, and while the treatment of the sick in military hospitals in peace time, so as to return them quickly in a fit condition to carry out their duties, is of great importance, it is only one aspect of Corps work, which is essentially a training ground for the surgeon himself and for all the staff of assistants, anæsthetists, sisters and orderlies who make up an operating team, and of all the auxiliary branches represented by the bacteriologist, radiologist and electro-therapeutist from whom the surgeon seeks assistance in the investigation and treatment of cases. Consequently every operation carried out in peace time in a military hospital is just as essential a part of Army training as the artillery practice camp or the musketry course of the infantry man. Further, it is only by surgical experience gained in peace time, added to the knowledge derived from actual field service, that our administrative officers can decide on suitable arrangements to approximate as closely as possible to peace time surgical conditions the conditions which will prevail in the war area.

My object is to give you some idea of the peace time surgery of the Army at present and you will be able to judge of its value to the Army :—

(i) As a life-saving measure. (ii) Financially by rendering men fit to continue as satisfactory soldiers. (iii) By affording a satisfactory training for a surgical staff to render them fit for their duties in the field.

In order to obtain information on this subject I have selected the surgical work carried out in the Home Command and the Colonies during 1925. The important operative work carried out in India is excluded, because the details of this work were not accessible to me.

The total figures I deal with are derived from returns sent to me by all surgical specialists every month in the Home Command and from the annual reports of the various commands and colonies.

The detailed analysis of certain groups of cases was obtained from the case cards supplied by A.M.D.2. I specially emphasize the value and importance of these cards ; if only officers realized their after-value, more care in their compilation might be exercised. Very frequently they are the important factors in deciding claims for pension by discharged soldiers, and if carelessly prepared injustice to the individual may occur, or, conversely, financial loss to the State.

I have selected two groups of surgical operation cases for analysis : one, because of the importance of the operation as a life-saving measure as well as a means of restoring men to full health : the other because it indicates how frequently operative measures are necessary in the Army, and the large number of men who are rendered efficient soldiers by means of surgery.

The extent of surgery done in the Army in peace will be indicated if I mention that, exclusive of India and of operations carried out in our Military Families' hospitals,

6,108 surgical operations were performed in one year, which is an average of 509 per month.

Of these operations 1,257 were intraperitoneal abdominal operations and from these I have selected the two groups of cases I wish to bring to your notice: (1) gastric and duodenal ulcer; (2) appendicitis. I meant also to deal with hernia, joint operations and the operative treatment of fractures, but I soon realized that there would be no time for this.

(1) Gastric and Duodenal Ulcer.

The treatment of patients suffering from gastric and duodenal ulcer is shared by the physician and surgeon, and I do not intend to attempt to draw any conclusions from the figures I put before you as to which of these methods is the best. The numbers are certainly not sufficient to attempt this.

The prominent feature of both gastric and duodenal ulcer from the patient's point of view is some disturbance of his digestive function, usually in the form of pain or discomfort at varying periods after the ingestion of food. Consequently, in dealing with this subject one has to consider the total number of cases in which the patients have suffered from stomach symptoms, and the actual number of these cases that have been proved to be gastric or duodenal ulcer.

During the year, for the whole Army, 1,181 admissions for inflammation of the stomach occurred and 296 in which the diagnosis was dyspepsia. It should be noted that these are admissions, and that the figures do not accurately represent the number of cases.

An analysis of the case cards for officers and men, exclusive of India, shows that forty-five cases were definitely diagnosed as gastric ulcer and fifty-nine as duodenal ulcer. Of these, twenty gastric ulcers and thirty-one duodenal ulcers were treated surgically during the year. This gives a total of fifty-one operations for these two conditions. Twenty-six of these operations were for perforation of an ulcer, and one death occurred, while twenty-five were for non-perforative lesions with two deaths. The total mortality of cases of gastric and duodenal ulcer submitted to operation was therefore 5·8 per cent.

Although the numbers are small it will be clearer if I deal with gastric and duodenal ulcers separately.

(A) Gastric Ulcer.

Out of forty-one cases amongst N.C.O.'s and men which were definitely diagnosed as gastric ulcer, sixteen were submitted to surgical operation, and in addition four officers were operated upon, making a total of twenty operations for this condition.

Mortality.

One death followed on these twenty operations, giving a mortality of 5 per cent. for all operations for this condition. This one death did not actually occur until 1926, but as the patient's gastric operation took place in 1925 it must be included in the mortality figure.

The patient was an officer, and subsequently to operation he developed symptoms pointing to obstruction at the site of anastomosis. A further operation was done in 1926 when the proximal loop was found to be kinked and obstructed, and in spite of a cross anastomosis he succumbed.

After-History of Cases operated on for Gastric Ulcer.

Two cases were not restored to complete health and were invalided. In one a perforation was dealt with as an emergency in a civil hospital, but a few months later, as the patient was still suffering from gastric symptoms with hæmatemesis and only weighed 8 stone 2 lb., and was unlikely ever to be fit for the duties of a soldier, he was discharged. The other made a

complete recovery from his gastric symptoms, but as bronchitis and a ventral hernia supervened, he was also invalided. Seventeen cases were reported as free from dyspeptic symptoms. Three of these operated upon near the end of the year still remained in hospital, but were nearly fit for duty. The remaining 14 patients all returned to duty and none of them required re-admission during the year.

While it is too early to regard all these cases as finally cured, the test of recovery in the Army is severe, necessitating the return to full military duty and a barrack room diet, which is certainly not an invalid dietary.

Perforated Gastric Ulcer.

No fewer than ten out of the twenty operations for gastric ulcer were emergency operations for perforation. As you all realize, this is a very serious condition, and according to Mr. Sherren involves a mortality of at least 95 per cent. unless treated surgically.

For the fifteen years up to 1904, St. Thomas's Hospital showed a death rate of 55 per cent. for perforated gastric ulcer. At St. Bartholomew's there were sixty-nine cases from 1897 to 1905; of these 49 per cent. died. At the London Hospital Mr. Sherren had 16 cases, operated upon within twenty-four hours; all of the patients recovered, but in 28 cases where more than twenty-four hours had elapsed since the perforation the death-rate was 50 per cent.

The mortality for 10 cases operated upon in the Army during the year was *nil*. In our cases, in addition to closure of the perforation by suture, in 2 cases posterior gastro-jejunostomy was carried out at the same time. In 3 cases the vermiform appendix was also removed, and in 5 drainage of the peritoneal cavity was instituted. All were operated upon within twelve hours of the perforation, which accounts for the fact that none died.

NON-PERFORATED GASTRIC ULCERS.

Ten cases were operated on. In all of these the ulcer was situated at the pylorus, and the operation consisted of a simple posterior gastro-jejunostomy. One death occurred in the case of an officer already referred to. All the other patients were completely relieved of their symptoms. Eight returned to duty and one, already referred to, was invalided for bronchitis and ventral hernia.

If any conclusions can be drawn from so few cases it would appear that a simple gastro-jejunostomy is a satisfactory method of treating a pyloric gastric ulcer, and that excision of the ulcer or partial gastrectomy is hardly indicated for simple ulcers in this situation.

In two of these cases the patients had been operated upon the previous year for closure of a perforated gastric ulcer, but a recurrence of gastric symptoms in the current year necessitated the performance of a posterior gastro-jejunostomy with completely satisfactory results.

These cases suggest that a careful watch should be kept on those cases in which suture of the perforation alone was carried out this year, and that when the condition of the patient warrants it the performance of a gastro-jejunostomy at the time the perforation is closed is good practice.

One case is worthy of special mention for it illustrates the occurrence of a duodenal ulcer and, later, of a gastric ulcer in the same patient. Early in the year this patient was successfully operated upon for a perforated duodenal ulcer which was closed by suture, but no gastro-jejunostomy was carried out. Dyspeptic symptoms recurred, and this time I had the opportunity of operating myself, and found a well-marked pyloric gastric ulcer. A gastro-jejunostomy restored him to complete health.

PREVIOUS HISTORY OF GASTRIC ULCER CASES.

From the history of these cases it would appear that gastric ulcer may give rise to very slight symptoms and that the process of ulceration may be rapid and lead to early perforation. Thus, in one perforated case there was no history of indigestion preceding perforation. In one case the patient admitted to slight pain only, one patient had indigestion for two months, and in one perforated case the patient gave a history of long-standing dyspepsia.

Hæmorrhage.—In only three cases is hæmorrhage shown to be the most prominent feature.

Age Incidence.—The average age of patients operated on for gastric ulcer was 30 years, ten being between 30 and 40 years.

Nine of the patients were of the rank of sergeant or above, and 3 were corporals. It might almost be described as a disease of non-commissioned officers.

(*b*) DUODENAL ULCER.

During the year 53 cases of non-commissioned officers and men were diagnosed as duodenal ulcer; of these 25 were treated surgically and 28 medically, and in addition 6 officers were operated on for this condition.

Mortality.

Out of the 31 cases operated upon 2 deaths occurred, giving a percentage mortality of 6·4 per cent. In one of these death was due to hæmorrhage from the ulcer after operation, and in the other to subphrenic abscess twenty-three days after a perforated ulcer had been closed by suture. Two men died without any operation being performed. In one case a man who had never reported sick was found dead in his bed in barracks, and post-mortem examination showed that a perforated duodenal ulcer was the cause of death. In the other case the patient was admitted to hospital deeply jaundiced, delirious and critically ill. He died next day, and post-mortem examination showed a duodenal ulcer and subphrenic abscess.

Perforated Duodenal Ulcer.

Of the thirty-one cases submitted to operation for duodenal ulcer sixteen required operation on account of perforation. In fifteen of these cases the perforation was situated on the anterior surface of the first part of the duodenum and in one case on the second part.

In five of these cases, in addition to closure of the perforation by suture, a posterior gastro-jejunostomy was carried out at the original operation; in three the appendix was removed, in one of which the appendix was gangrenous.

The ages at which perforation occurred were as follows:—Two at 20, eight between 20 and 30 years, and five between 30 and 40 years.

One death followed operation for a perforated duodenal ulcer. This man developed a subphrenic abscess, and a further operation to drain this was carried out twenty-three days after the primary operation, but he died from toxæmia. The mortality from perforated duodenal ulcer was therefore 6·2 per cent.

In 1899 Pagenstecher[1] reported the first series of twenty nine cases of perforated duodenal ulcers treated by operation, and his mortality record was 86 per cent. Mayo Robson reported 155 cases with a mortality of 66 per cent. In the London Hospital from 1899 to 1908, forty-two cases occurred with a mortality of 80 per cent.

The next period from 1909 to 1919 showed a marked improvement and the mortality of 218 cases was 49 per cent. Mr. Sherren operated on forty-six cases with thirty recoveries, a mortality of 34 per cent.

[1] *Deutsche Zeitschr. f. Chir.*, 1899. lii. p. 541.

The Army figure of 6·2 per cent. for sixteen cases is better than any of these, as I consider it ought to be, for we are dealing with a selected young male, who, as soon as he is seized with abdominal pain, is promptly rushed into hospital. And again, all our cases are operated upon early, which is the essential factor in success. In three, the operation was carried out within three hours of the perforation. In only one case had twenty-four hours elapsed. All the others were operated upon within the twelve-hour period.

A point of interest in these statistics is the question of the subsequent history of patients who have recovered after simple suture of the perforation and for whom a gastro-jejunostomy has not also been done. When a gastro-jejunostomy has also been performed, the smooth convalescence, the earlier feeding that can be carried out, and the removal of the dread of another possible operation, are all points in favour of this procedure. It is clear that in a fair number of cases in which simple suture alone was carried out the patients were free from symptoms and returned to duty and a full diet.

On the other hand, in three cases in which a perforation had been closed by suture, one in 1921, one in 1924 and one in the present year, the patients required subsequent operation in 1925 on account of persistence or recurrence of symptoms. In two of these a posterior gastro-jejunostomy was carried out, and in the other adhesions were dealt with; all made good recoveries.

One other case I have already referred to, in which the patient had a perforated duodenal ulcer closed by suture early in the year, and at a subsequent operation was found to have developed gastric ulcer. If the conditions favourable to ulcer formation could have been corrected by a gastro-jejunostomy at the first operation, it is unlikely that this gastric ulcer would have developed.

Some cases are in such a serious condition when perforation has occurred that closure of the leaking point is all that should be attempted, but cases seen early and in good surgical condition should be given the benefit of an immediate gastro-jejunostomy. This procedure only adds about ten minutes to the operation.

Final results.

The final condition of the men who recovered after perforation must be considered as satisfactory. They all returned to duty, and, as I have pointed out in dealing with gastric ulcer, this involves a barrack room dietary.

Operations for the Cure of Duodenal Ulcer in Cases that had not Perforated on Admission to Hospital.

Fifteen cases were operated on for conditions which were diagnosed on clinical, laboratory and radiological examination as duodenal ulcer.

In one case the diagnosis was not confirmed at operation. The appendix had been removed in 1923, but pain persisted and the results of an opaque meal examination pointed strongly to duodenal ulcer. At operation a careful examination failed to reveal any ulcer and the abdomen was closed. His pain was completely relieved and he returned to duty.

There was one death amongst this group of cases. This man, who had complained of dyspepsia for three weeks, looked pale and ill, and had occult blood in his stools. At operation a duodenal ulcer was demonstrated. A gastro-jejunostomy was done, a chronic appendix removed, and a well-marked Lane's band and also adhesions between the gall-bladder and stomach divided. After operation severe hæmatemesis occurred, and in spite of blood transfusion he never rallied. No post-mortem examination was permitted, but it is believed that the bleeding took place from the ulcer, as the suture line at the anastomosis was carefully done, and no bleeding occurred when the light clamps were released.

This case suggests that safety in this direction might be increased by cauterization and suture of the ulcer.

In two cases operation was undertaken for bleeding, one four days after admission and the other after one month of medical treatment. In both, a simple gastro-jejunostomy was done; the men made good recoveries and returned to duty.

The remaining cases operated upon presented the classical, clinical and laboratory signs of duodenal ulcer, and all made straightforward recoveries with the exception of one.

In this case vomiting commenced after operation, and persisted in spite of washing out of the stomach. The abdomen was again opened and it was found that owing to a hæmatoma between the layers of the transverse mesocolon the proximal and distal loops were glued together. The stoma was patent into the distal loop but the proximal loop was blocked. A cross-anastomosis between the proximal and distal loops was carried out and the patient made a perfect recovery.

With regard to the operative technique employed:—

(*a*) It is noted that suture of the perforated ulcer succeeded in stopping the leak in all but one case. This case, referred to as a failure, terminated fatally from subphrenic abscess, but even in this case it is not certain that further leakage from the perforation occurred after suture.

(*b*) In all cases in which gastro-jejunostomy was performed the posterior no-loop method was adopted, and catgut only was used as suture material.

(*c*) The tendency has been to discard heavy and complicated types of clamps and to rely on very light clamps to avoid danger from injurious pressure, especially to the loop of jejunum.

(*d*) It is noteworthy that no case of gastro-jejunal or jejunal ulcer has been seen in military practice during the year, and this I attribute to non-removal of any mucous membrane before the anastomosis is made.

(*e*) No local treatment to the ulcer was undertaken in any of the non-perforated cases.

(*f*) The value of cauterization and suture is recognized, and the death which occurred from bleeding from the ulcer following operation might have been obviated if this procedure had been adopted.

While the general results obtained during the year by operation for these two serious conditions, gastric and duodenal ulcer, are satisfactory, it is nevertheless a little disquieting to reflect that out of fifty-one operations performed no less than twenty-six, or over half the total, had to be undertaken for the serious condition of perforation. For ulcer cases to be left until this grave catastrophe occurs suggests a lack of investigation or defective diagnostic powers, and the question arises, in how many other of the 1,487 cases diagnosed as gastritis or dyspepsia the patients were really suffering from true ulceration. Perforation may have been a blessing in disguise for some of the cases, for it led to operation, and in a large proportion to complete relief from their trouble.

(II) Appendicitis.

When I tell you that 942 admissions occurred for appendicitis during the year, with seventeen deaths, and in the Home Command and Colonies 604 operations were found to be necessary for this condition, you will agree that the subject deserves consideration.

It would be interesting if we could glean any information as to the incidence of appendicitis among the civil population to compare with the incidence of this disease in the Army. Unfortunately there is no method of acquiring this knowledge as the returns of the Registrar-General deal only with deaths from this condition. But

the records show that in 1913 the deaths amounted to sixty-nine per million, while in 1923 they had risen to seventy-four per million for the whole population.

In the Army, the year 1925 showed an increase of admissions over the previous year, 942 as against 881 for 1924.

With regard to operative mortality there are published figures with which comparison can be made, and this comparison is useful provided we make allowance for many factors which favour the Army, the most important being that all cases, with few exceptions, are sent to, and treated in, hospital from the outset, and that the great majority are operated upon in the early and favourable stage.

During the year, in the Home Command and Colonies, 604 operations for appendicitis were performed with a mortality of six, a total percentage death-rate of 0·96 for operations at all stages of the disease. But as all the deaths followed operations for acute attacks at various stages it gives a fairer comparison if we deal with acute attacks alone. 208 were recorded as acute. 121 are shown as chronic and 275 are not classified. If we accept all the deaths as occurring amongst the 208 recorded as acute, which is certainly over-stating the case, we get a percentage mortality of 2·8 per cent.

Mr. Adams, in a valuable paper read before the Section of Surgery of this Society last year, gave the figures for the London Hospital and St. Thomas's Hospital. These figures dealt with the mortality following operation at the various stages of the disease, and time will not permit me to go into all these nor have I data from Army records which would usefully compare with the data from these stages.

The total mortality for all operations, including all stages of the disease, was 5·8 for the London Hospital and 8·4 for St. Thomas's Hospital. Where operation was done within twenty-four hours of the onset of the disease the London Hospital cases show a mortality of 0·9 per cent. and those at St. Thomas's 2·3 per cent.

Mr. Sherren has drawn attention to the fact that pain in the right iliac fossa does not necessarily signify appendicitis nor is it interpreted in this way in the Army. From personal contact with the patients I can assure you that the cases shown as operated upon for appendicitis in the Army really suffered from the disease.

Much has been written about unnecessary operations for supposed affections of the appendix, especially directed towards the removal of the appendix for the symptom of pain in the right iliac fossa, and drawing attention to the large number of cases which are not benefited by the operation. 121 cases were shown in the operation returns as chronic appendicitis, and if these had been wrongly diagnosed and the cases had been unrelieved by operation a higher invaliding rate than eight would be expected. This figure (eight) of course refers to all cases of appendicitis acute and chronic.

The method of the approach to the appendix has varied. In a very few the old muscle-splitting operation has been employed. In a slightly larger number Battle's incision placed at the outer margin of the rectus has been employed, but by far the most common is a paramedian incision. The facilities this incision gives for a general examination of the whole abdominal viscera has frequently been of value and other morbid conditions have been discovered.

Whilst no ill results following the other incisions have been noted in cases operated upon in the Home Command, two cases invalided from India show the bad results of extension of an incision placed at the outer margin of the rectus, and consequent damage to the nerve supply of the muscle.

Following drainage of appendix abscesses twelve cases of ventral hernia required operation during the year, but some of these original operations had been carried out in previous years.

All the deaths from appendicitis were due to an extension of the peritoneal

inflammation. In three of the fatal cases the patients underwent subsequent operations performed for obstructive symptoms. In two cases an enterostomy and an entero-anastomosis were done, and in one case a cæcostomy.

The final results of operation for appendicitis were satisfactory and the total number of cases invalided for this disease was eight.

As the total number of deaths from appendicitis is shown as 17, and as only 6 of these followed 604 operations performed outside India, it is clear that the percentage mortality following operation in India must have been higher. I have no very special reason to advance to account for this except that cases in India are liable to be complicated by intercurrent diseases such as malaria and dysentery, and the climatic conditions in the plains of India during the hot weather are less favourable to surgical operation.

I must omit reference to many types of operation but the two groups I have so inadequately described may help in giving a general idea of the extent of military surgery in peace time and enable you to judge of its adequacy as a training ground for the surgery of war.

In considering results, and in comparing them with civilian statistics where comparison is possible, it must be borne in mind that these operations described have been carried out by a number of young general surgeons who must be prepared to undertake any type of surgical work, and that they differ in this respect from the work of abdominal or orthopædic specialists devoting the greater part of their time to their own speciality.

Had time permitted I would have alluded to the work of many of the special departments without the aid of which good surgery would not be possible or good results obtained; of such may be mentioned the radiological, the massage, and electro-therapeutic departments.

Discussion.—Surgeon Commander H. E. R. STEPHENS referred to the close collaboration between the medical and surgical sections in naval hospitals during the investigation of cases of gastric and duodenal ulcers. Statistics from the Royal Naval Hospital, Haslar, corresponded closely with those given by Colonel West.

	Total number	Deaths	Mortality
Gastro-enterostomy ...	34	2	6 per cent.
Gastro-duodenostomy ...	14	0	nil
Perforated gastric ulcer	28	1	4 per cent.
Perforated duodenal ulcer	10	0	nil
Appendicectomy ...	341	3	9 per cent.

From a Service point of view he considered that the results of gastro-duodenostomy were superior to those of gastro-jejunostomy. He did not agree that gastro-jejunostomy should be performed as a routine measure in cases of perforation. Many perforations, he considered, were caused by acute ulceration; many of the chronic cases were cured by simple suture; also, in the event of symptoms recurring, there seemed no valid reason why gastro-jejunostomy should not be performed subsequently. He looked upon the operation for perforated gastric or duodenal ulcer essentially as a life-saving measure, and if gastro-jejunostomy was performed at the same time he felt that the mortality rates would increase. Unless the case was seen early and the condition of the patient exceptionally good, he did not think the increased risk to the patient's life was justifiable. The similarity of the statistics he attributed to the similar conditions under which naval and military surgeons worked. Patients were of excellent physique and in the majority of cases they were brought under the care of the operating surgeon with the least possible delay.

Air Vice-Marshal D. MUNRO said that he was specially interested in the statistics of post-operative gastric and duodenal cases in which the patients were returned to full duty. Presumably these were men who were considered fit for military service at home and in all overseas climates in peace and war. The numbers caused him surprise. He would ask one

question, viz.: if any of these men relapsed whilst serving in a hot climate and eating what Colonel West had termed "barrack diet," and were afterwards invalided from the Service, what view would Colonel West take as to the part played by these factors in making the invaliding disability attributable to Service conditions? On this decision—in making which he (Air Vice-Marshal Munro) was the final authority—payment of disability pensions depended and he was thus particularly concerned.

Colonel WEST, in reply to Surgeon Commander Stephens, stated that the operation of gastro-duodenostomy had not been employed in any of the cases recorded. He considered it a valuable method, but gastro-jejunostomy had proved so satisfactory in the Army that the necessity for the other method had not arisen. With regard to the performance of a gastro-jejunostomy at the same time that a perforative lesion was dealt with, he agreed that this should only be attempted in selected cases in which the patients were seen early after the perforation and were in good surgical condition. If these conditions were fulfilled he had no hesitation in recommending that the operation should be done.

In reply to Air Vice-Marshal Munro, Colonel West said that there was no reason why patients who had been successfully operated upon for gastric or duodenal ulcer should not be passed fit for foreign service, but in the event of these men being later discharged as unfit for service, such foreign service might have to be considered as aggravating their condition.

